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THE PLANT DISEASE SURVEY
SECTION OF MYCOLOGY AND DISEASE SURVEY

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IN THIS ISSUE

G. B. Lucas and L. H. Person describe the procedure by which they obtained germination of oospores of the tobacco blue mold fungus, page 243.

Further improvement in methods of forecasting potato and tomato late blight occurrence is reported by R. A. Hyre, page 245.

J. M. Ogawa et al. report the results of a survey for brown rot of stone fruits in California, page 254.

The special care needed to prevent introduction of viruses in symptomless host carriers is emphasized in J. A. Milbrath's account of the detection of the "Eckelrader" disease in cherry importations from Europe, page 258.

Ringspot, a virus disease of cultivated blueberry in New Jersey, is described by M. T. Hutchinson and E. H. Varney, page 260.

Studies reported by C. E. Yarwood, page 263, suggest a connection between tobacco-necrosis virus and lettuce big vein in California.

G. W. Bruehl discusses the host range of the chlorotic streak virus disease of sugar cane, important in Puerto Rico; discrepancies in reported observations may possibly be due to the existence of more than one strain, page 264.

Yield comparisons between wheat varieties grown on mosaic-virus-infested and noninfested soil in Illinois are reported by Wayne M. Bever and J. W. Pendleton, page 266.

J. M. Raeder proves that the wheat nematode can remain viable and active over a period of 14 years of dormancy, page 268.

The dryland root rot complex of winter wheat was widespread in eastern New Mexico in 1953, according to C. H. Hsi, who discusses the factors that favored its occurrence, page 270.

S. S. Ivanoff describes spikelet-drop of oats, in Mississippi, page 275.

Jack P. Meiners reports some grass diseases observed on new hosts at Pullman, Washington, in 1953, page 277.

Incidence of forage plant diseases in northern West Virginia in 1953 is reported by Edward S. Elliott, page 279.

A new physiologic race of bean rust is reported from New Mexico by W. P. Sappenfield, page 282.

Lee Campbell summarizes results of tests with various chemicals for the control of cauliflower club root in Washington, page 283.

Association of various fungi with poor germination of 1953-crop sweet alyssum seed is reported by W. F. Crosier and C. E. Heit, page 286.

Bert M. Zuckerman reports observations on the relation of type and age of wounds to infection by the oak wilt fungus, page 290.

Both A and B strains of the oak wilt fungus were present in most areas from which isolates were obtained during the 1951-52 Pennsylvania oak wilt survey, according to William L. Yount, page 293.

The suggestion that Corticium galactinum may be the cause of white pine needle blight is not borne out by research reported by Richard J. Campana, page 297.

Distribution and amount of damage to cotton from Fusarium and Verticillium wilts in Tennessee for the three-year period 1951-1953 is discussed by James M. Epps and others, page 304.

The concentration of salt in the soil seems to be a factor in severity of cotton Verticillium wilt, according to observations reported from Texas by P. D. Christensen and others, page 309.

Bowen S. Crandall and Harold D. Lynn report reaction of kenaf varieties and relatives to anthracnose, as observed in the breeding program in Cuba, page 311.

J. D. Menzies reports some new or unusual plant disease developments in irrigated central Washington during 1953, page 314.

Brief Notes, page 316: Teaching of plant pathology at West Virginia University, by C. R. Orton.

Announcement, page 316: Two more coined names for fungicidal chemicals

Attention Please, page 316: Contributors please note.

February weather, page 317.

FACTORS INFLUENCING OOSPORE GERMINATION IN PERONOSPORA TABACINA

G. B. Lucas and L. H. Person[1]

The blue mold fungus, Peronospora tabacina, is an obligate parasite and causes downy mildew or blue mold of tobacco, a destructive seedling disease. It is well known that the fungus frequently forms oospores in great numbers in dead or dying leaves of blue mold-affected plants, but the conditions necessary for oospore formation are not at all well known. Furthermore, knowledge of the life cycle of the fungus is incomplete although there is good circumstantial evidence that overwintering oospores germinate to start primary infections if last year's plant bed is used.

Just how the oospores germinate and the conditions that must be met before they will germinate have not hitherto been known. In fact, for the entire genus Peronospora, which includes more than 140 species, there are not many accounts of oospore formation and only a few reports of oospore germination. In the few reports that have been made, oospore germination usually is said to be by germ tube or by zoosporangia borne on short hyphae. To put it briefly, our knowledge of the sexual stages of the downy mildew fungi is exceedingly scanty.

The only published account of oospore germination in P. tabacina is that by Wolf and his coworkers in 1936. These investigators exposed diseased leaves containing oospores to alternating cold and warm temperatures for about six months. At the end of this time an occasional oospore produced a germ tube when bits of stored material were macerated and kept in drops of water on microscope slides.

In April 1952 we collected leaves of tobacco seedlings affected by blue mold. Some leaves as big as a 50-cent piece contained more than 1000 oospores. Many attempts were made to germinate these oospores, using among others, the techniques of Wolf et al., but no spores were seen to germinate although thousands were examined.

In October 1952 leaves containing oospores were placed in the top layer of sterilized soil in 4-inch pots. Tobacco seed were sown and plastic chimneys placed over the pots. The seeds germinated in about a week. Approximately one month after the pots had been inoculated, blue mold appeared on some of the seedlings. The experiment was repeated several times and in each case blue mold was obtained when oospores were used as inoculum; this indicated that some of the spores were viable. No previous records reporting infection under controlled conditions with oospores in leaf material have been found in the literature.

To determine whether or not infection actually originated from germinating oospores the following experiments were performed. Small pieces of leaf material containing oospores were placed on the soil surface of 4-inch pots in which tobacco seedlings were growing. The pots were placed in a cold room maintained at 65° F. They were illuminated by daylight fluorescent light for 12 hours daily and the soil was kept moist. At intervals some of the material was examined microscopically. About three weeks after the oospores had been subjected to these conditions it was noticed that rigid, thin-walled hyaline vesicles were attached to some oospores. In each case this vesicle or sporangium was attached directly to the oospore.

When the oospores with attached sporangia were placed in water, the protoplasm in the sporangium differentiated to form zoospores within 20 minutes. Some sporangia contained as many as 200 zoospores, each of which measured about 5 microns or less in diameter. The zoospores emerged through the wall singly and quickly. Oospores with attached sporangia have been seen in material so treated at least ten different times. Of more than one million oospores examined, none were seen to form germ tubes.

Drops of water containing oospores and zoospores have been used to inoculate tobacco seedlings. Conidia and conidiophores of the blue mold fungus developed in a week or ten days.

In our experiments oospores stored dry from 4 to 20 months formed sporangia. The sporangia formed on moist soil in the absence of tobacco seedlings. The sporangia did not form in water or dry soil. The sporangia formed at 55°, 65°, and 75° F. In general, sporangia were produced in three to four weeks when oospores were kept on moist soil at 65° with alternating 12-hour periods of light and darkness. The regularity of their formation and attachment to the oospores suggests the possibility that these zoosporangia are the products of normal germination of the oospores of Peronospora tabacina.

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No other report has been found of oospore germination in the genus Peronospora by the production of a sessile zoosporangium.

The information here reported is of value in several different directions:
1) It establishes the role and importance of oospores as sources of primary inoculum, and the need to eliminate them if blue mold is to be eradicated.
2) It will enable us to complete the life history of the fungus and to learn new facts concerning the genetics of the organism.
3) The factors found necessary for germination of oospores of P. tabacina may furnish clues to enable workers to germinate oospores of other closely related species.
4) The mode of oospore germination and presence or absence of zoospores in the Peronosporaceae and realted families will indicate taxonomic and phylogenetic relationships.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION, AND U. S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE, COOPERATING

PROGRESS IN FORECASTING LATE BLIGHT OF POTATO AND TOMATO

R. A. Hyre[1, 2]

Van Everdingen (3) first proposed a method for forecasting late blight (Phytophthora infestans) of potato about 27 years ago. Since that time various modifications of his four "Dutch rules", and new methods as well, have been proposed in an effort to find an effective, practical way of predicting this disease. The literature on forecasting blight, and on reporting its presence, has been reviewed recently by Miller and O'Brien (7). Much of the literature on a related subject, that of correlating weather with occurence of blight, has been reviewed by Crosier and Reddick (2), and by Cook (1). An additional study, not included in the reviews, was that by Tilford in Ohio, (10) who found "a definite correlation between excess rainfall during the growing season and the occurrence of blight."

In Europe, blight forecasts have been based primarily on relative humidity and temperature. Grainger (4), in Scotland, has illustrated mechanisms for simplifying the obtaining of relative humidity and temperature records. He notes, however, that the hair hygrograph is "temperamental", the Gregory humidity recorder is "costly", and that a greater number of reporting stations is needed in closer relation to the crops if blight forecasting is to become a fully practical proposition.

In the United States, rainfall and temperature have been emphasized in the development of forecasting systems. Recently, however, Wallin (11) has reported success with the use of relative humidity and temperature records. Reddick (9) noted that correlation is usually very good between rainfall and development and spread of blight. He emphasized, however, that it is the simultaneous occurrence of adequate moisture and favorable temperature that results in the development of late blight epiphytotics. Either factor alone, if unfavorable, may prevent the development of blight, even though the other one is favorable.

After the epiphytotic of tomato late blight in 1946, Cook (1) developed a new method of forecasting this disease. Applying this method to past years, predictions made from charts of temperature and cumulated rainfall would have been 84 and 81 percent successful, respectively, for the Norfolk, Virginia and Charleston, South Carolina areas, the error being in prediction of blight in some years when it did not reach epiphytotic proportions. Nugent (8) has successfully continued the forecasts at Norfolk. A similar method was applied elsewhere by other workers. Hyre and Horsfall (6) reported 78 percent successful forecasts of late blight of potato for a 49-year period in Connecticut. On the other hand, Wallin et al. (12, 13, 14) found forecasts by this method unreliable for Iowa, Indiana, and Wisconsin.

A modification of Cook's method is reported here. It is an extension of "moving" rainfall and temperature analyses which Cook used in a limited way.

Methods

Procedures will be described, in turn, for (a) determining the seasonal starting date for forecasting late blight of potato in Connecticut; (b) forecasting by use of a cumulated rainfall-moving temperature analysis; and (c) forecasting by means of moving rainfall and temperature analyses. The first two methods are, essentially, the same as those used by Cook; the third is an application of his method for determining the seasonal starting date to the actual forecasting itself. Rainfall and temperature data were compiled from U. S. Weather Bureau Climatological Data.

(a) To determine the seasonal starting date of potato late blight forecasts in Connecticut, daily precipitation for Hartford and New Haven were combined for 11 non-blight years (those listed in Fig. 4, expecting 1953), and for 13 "much-blight" years, and plotted by means of 7-day moving graphs (Fig. 1). Each point on the lines is the total rainfall for a 7-day period, ending that day. Thus the total rainfall for June 1 to 7, inclusive, is plotted on June 7; that for June 2 to 8, on June 8; that for June 3 to 9, on June 9, etc. Mean daily temperatures for the two stations were combined and are similarly plotted as 7-day averages of the means, so that each point on the temperature lines represents the average of the mean temperatures for a 7-day period, ending that day. As seen in Figure 1, the temperature lines fall below 75° F and temperature is there-

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[2] The author is indebted to Dr. James G. Horsfall, of the Connecticut Agricultural Experiment Station, for the Connecticut late blight records.

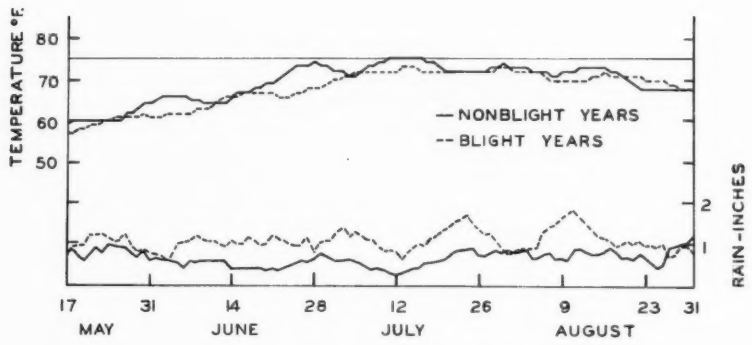

FIGURE 1. Comparison of the rainfall and temperature, at Hartford and New Haven, of 11 nonblight and 13 much-blight years in Connecticut. Each point on the rainfall lines represents the total rainfall for the 7-day period ending that day, and each point on the temperature lines represents the average of the mean temperature of the days during the 7-day period.

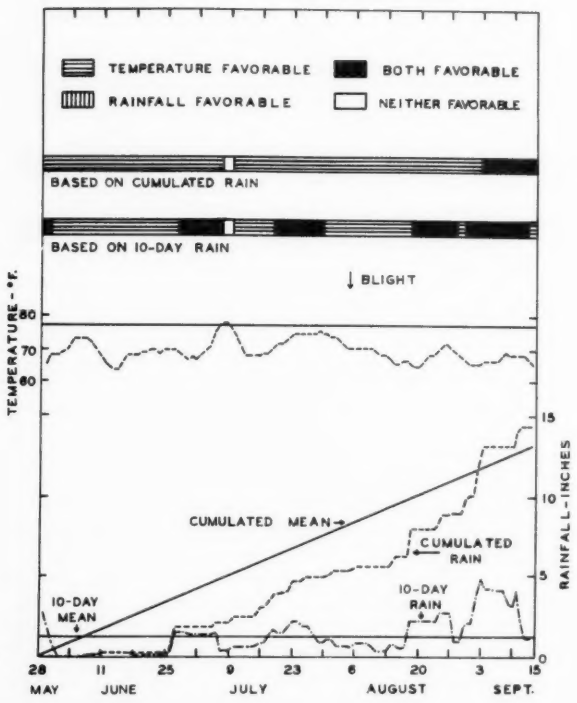

FIGURE 2. Forecasting late blight of potato in Connecticut for the year 1919 by means of 10-day moving rainfall, cumulative rainfall, and 7-day moving temperature graphs.

fore considered not to be limiting the development of blight (1). The rainfall lines rather permanently diverge, starting on June 4, with more rain occurring in the blight years than in the nonblight years. Since rainfall plotted on June 4 represents total rainfall for a 7-day period, conditions favorable for blight are considered to have started about May 29.

(b) For the cumulative rainfall-moving temperature method the rainfall is cumulated daily, beginning with the date on which conditions favorable for blight started. Rainfall is considered favorable for blight when cumulated rainfall equals, or exceeds, the cumulated average (average daily rainfall, obtained from Climatological Data, cumulated daily). For Connecticut the cumulated average rainfall line happens to be the same as a "critical" line determined for Connecticut by Cook's method. The latter is a line drawn midway between lines representing cumulated rainfall for the blight and for the nonblight years, respectively. Temperature is plotted on a 7-day moving basis as in (a). Temperature is considered favorable for blight when the average temperature does not exceed an assumed "critical" temperature.

(c) For the moving rainfall-temperature method, the rainfall line on a 7-day basis is constructed as described in (a) for determining the start of the seasonal forecasting period in Connecticut. In addition, the usefulness of a similarly derived 10-day moving line was investigated, each point on the line representing the total rainfall for a 10-day period, ending that day. For example, the total rainfall for June 1 to 10, inclusive, is plotted on June 10; that for June 2 to 11, on June 11; that for June 3 to 12, on June 12; etc. Rainfall is considered favorable for blight when the 7-day total rainfall equals or exceeds the 7-day average, or the 10-day total equals or exceeds the 10-day average, depending upon which criteria are being used. Temperature is plotted on a 7-day moving basis, as explained in (a) above.

Inadequacy of the Cumulative Rainfall Method

Using Connecticut data, two situations will be illustrated in which the cumulative rainfall method failed to forecast blight satisfactorily, whereas the moving rainfall method was a decided improvement. Early-season rainfall was deficient in one case, excessive in the second.

In the year 1919 rainfall was deficient during most of June (Fig. 2), and though the amount was above normal for the rest of the season, the cumulated rainfall line remained below the cumulated mean line until early September. Thus, by this method, blight would not have been forecast until the second week of September. Actually, it was first reported on August 4, and all vines were dead at the Mount Carmel Experimental Farm by the end of August. By the 10-day moving rainfall method, on the other hand, blight would have been successfully forecast, since there were two periods favorable for blight (one of 10 days, the other of 11 days) before blight was first reported. Also, this method indicated favorable blight weather during late August and early September when blight was epiphytotic.

In 1936 rainfall was excessive for 5 days in June but below normal the remainder of the season (Fig. 3). The cumulated rainfall line rose so far above the cumulated mean line that it remained above the rest of the season even though rainfall was deficient. Blight would have been forecast for nearly the entire season by the cumulative rainfall method, whereas in reality it was first reported on September 11 and there were only five reports for the entire State. Only light disease occurred except in one late-planted field. The 10-day moving rainfall method would have indicated one blight-favorable period of 16 days during June, but only short periods of favorable weather during the remainder of the season.

Effectiveness of the Different Methods for Forecasting Late Blight of Potato in Connecticut

A comparison was made of forecasts of potato late blight in Connecticut from different combinations of temperature with cumulated and moving rainfall. The forecast period was from May 29 to August 31 each year for the years 1902 to 1953, inclusive. The days when both temperature and rainfall were favorable for blight were determined. Temperature was considered favorable when the 7-day average did not exceed either 75°, 77°, or 79° F. Rainfall was considered favorable if it equalled or exceeded the respective means (11.59, 0.85, and 1.21 inches) when it was cumulated, or totalled by either 7-day or 10-day periods. Then blight was forecast, experimentally after either 6, 8, 10, 12, or 14 consecutive favorable days. Figure 4 gives the summary of rainfall and temperature relations for the criteria of 10-day rainfall and 77° F temperature, the forecast of blight (after 10 consecutive favorable days during the period of May 29 to Septem-

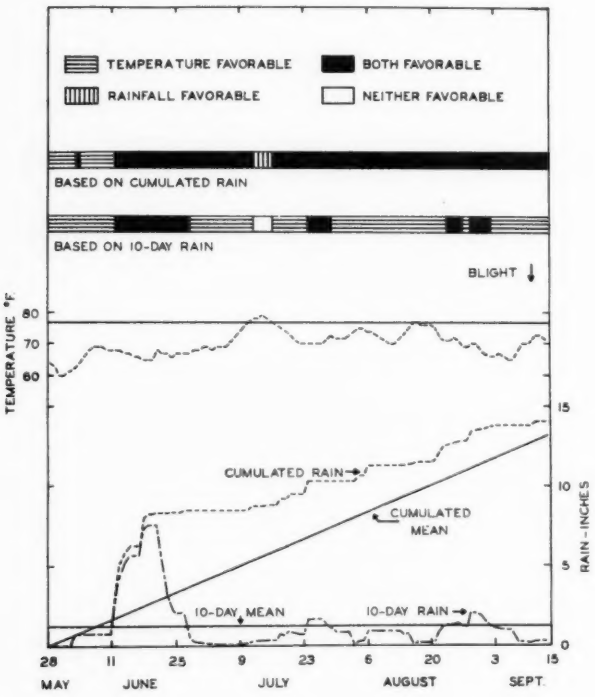

FIGURE 3. Forecasting late blight of potato in Connecticut for the year 1936 by means of 10-day moving rainfall, cumulative rainfall, and 7-day moving temperature graphs.

Table 1. Accuracy of Connecticut late blight forecasts developed from different combinations of temperature and rainfall data.

Temperature-rainfall combination	Percentage accuracy of blight forecasts		
	Presence	Absence	Presence and absence
A. Temperature: 7-day mean $\geqq$ 77° F. Consecutive favorable days = 10 Rainfall:			
1. 10-day total $\geqq$ 10-day mean	100	31	83
2. 7-day total $\geqq$ 7-day mean	74	54	69
3. Cumulated daily amount $\geqq$ cumulated daily average amount	74	62	71
B. Temperature: 7-day mean $\geqq$ 77° F. Consecutive favorable days = 8 Rainfall:			
1. 10-day total $\geqq$ 10-day mean	100	23	81
2. 7-day total $\geqq$ 7-day mean	87	46	77
3. Cumulated daily amount $\geqq$ cumulated daily average amount	77	62	73

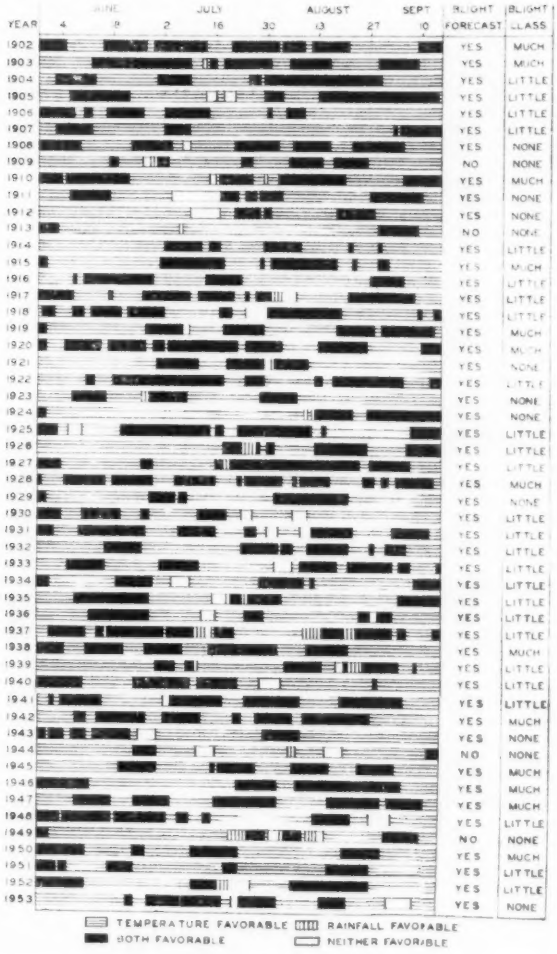

FIGURE 4. Summary of the temperature and rainfall for Hartford and New Haven, in relation to the importance of late blight of potato in Connecticut, for the period 1902-53. Late blight was forecast after both temperature and rainfall were favorable for the disease for 10 consecutive days.

ber 1), and the occurrence of blight. The accuracy of the predictions made from all combinations investigated is summarized in Figure 5.
utive favorable days derived from a critical temperature of either 77° or 79° F, and 10-day rainfall equalling or exceeding the 10-day mean. The accuracy was considerably less when a forecast of blight was not made until after 12 or 14 consecutive favorable days. Predictions were least accurate with a critical temperature of 75°. Also, they were less accurate when based on 7-day rainfall, as compared to 10-day rainfall. Predictions based on cumulated rainfall were about 70 percent accurate.

The successful prediction of blight in the years that it occurs, to any appreciable extent at least, is much more important than to avoid predicting blight when blight fails to occur. In the latter case control measures would probably be recommended for only a short period anyway. It is important then, to analyze the accuracy of forecasts in terms of eventual presence or absence of the disease. Such an analysis is given in Table 1 for forecasts made after 10, and 8, consecutive favorable days based on 77° F temperature and cumulated, 10-day, and 7-day rainfall.

On a 10-day rainfall basis, blight was predicted every year that it occurred when either 10, or 8, consecutive favorable days preceded a prediction of blight. The 17 percent error in overall forecasts was due entirely to failure of blight to occur (or be reported) during some

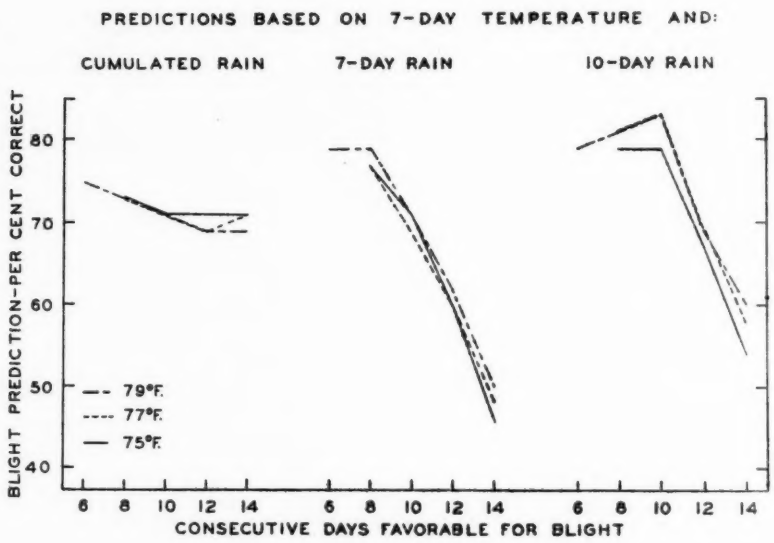

FIGURE 5. Summary of the accuracy of Connecticut late blight forecasts for the period 1902-53.

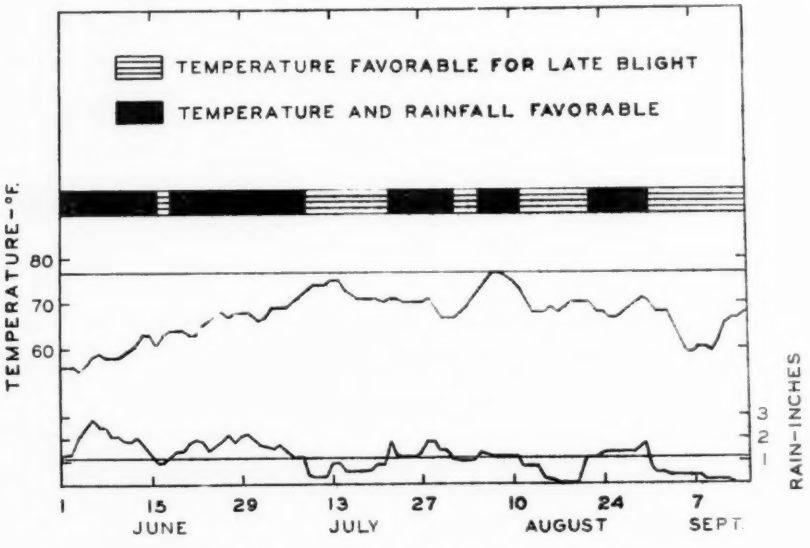

FIGURE 6. Forecasting late blight of potato at Ithaca, New York, in 1928, by means of 10-day moving rainfall, and 7-day moving temperature, graphs.

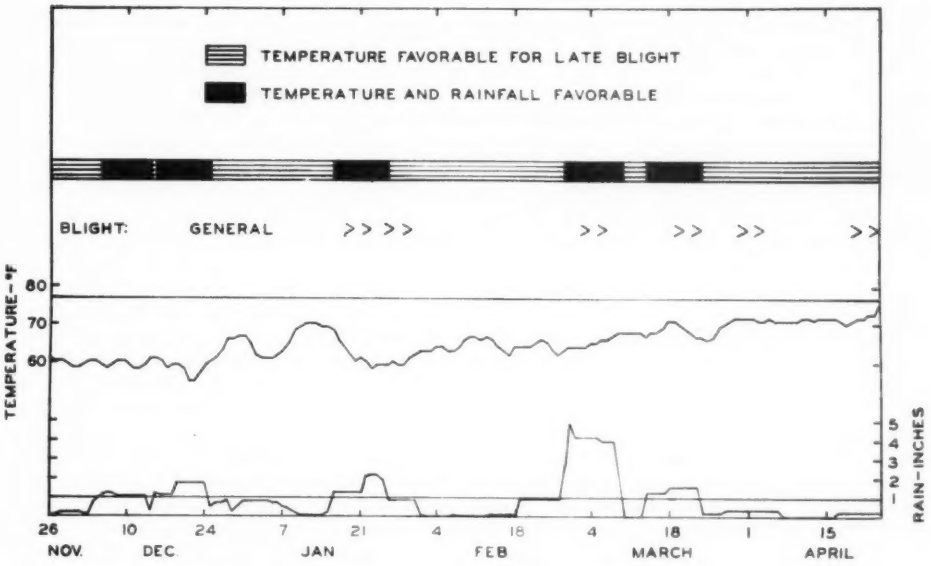

FIGURE 7. Forecasting late blight of tomato on the west coast of Florida in 1945-46, by means of 10-day moving rainfall, and 7-day moving temperature, graphs.

years for which it was forecast. Less accurate predictions resulted with 7-day total, or cumulated, rainfall. The criteria suggested as worthy of trial in Connecticut are 10 consecutive favorable days derived from 77° F critical temperature, and 10-day rainfall.

Forecasting Late Blight of Potato At Ithaca, New York, in 1928

Reddick (9) reported "very pronounced spread" of blight at Ithaca, New York, in 1928, with "no measurable precipitation at all." He attributed it to cool nights with heavy dew.

The possible successful prediction of blight that year, by the moving temperature and 10-day rainfall method, was investigated. Days were considered favorable for blight when the temperature did not exceed 77° F, and the 10-day rainfall was greater than a 10-day mean of 1.21 inches (the 10-day mean for Connecticut). As seen in Figure 6, there were five periods favorable for blight during June, July, and August. The results were the same when the Ithaca 10-day mean of 1.15 inches was used. Thus, late blight initiation and increase would have been forecast very successfully from precipitation and temperature data.

Forecasting Late Blight of Tomato on the West Coast of Florida in 1945-46.

Harrison (5) reported that late blight of tomato was unusually destructive in the Bradenton, Florida, area during the season of 1945-46. The disease was first observed on November 26, 1945. It gradually increased but did not become general over the Hillsborough-Manatee County tomato belt until late December. Then it became "unusually active and destructive" during two periods in January, three in March (the first one of these starting in February), and one in April. He gives hygrothermograph records made during these six periods that show long periods of 100 percent relative humidity, and states: "Long periods of high humidity were necessary for the rapid spread and development of late blight. This point is further illustrated by the fact that even though the relative humidity was 100 percent for 10 to 15 hours practically every night during the entire season, late blight was relatively inactive except during the six periods mentioned."

The occurrence of late blight, however, could have been forecast by moving rainfall and

temperature data. Rainfall and temperature data, from U. S. Weather Bureau Climatological Data, for Bradenton and Tampa were combined. Rainfall was plotted on a 10-day moving basis and average temperature on a 7-day moving basis. The favorable days for blight were plotted on the basis of 10-day rainfall equalling or exceeding 1 inch and average temperature not exceeding 77° F. The average 10-day rainfall for the months involved is 0.8 inch; that for Connecticut is 1.21 inch. The reference line is placed at 1.0 inch in the absence of a precise determination of the position of this line from blight records of past years. Fewer favorable periods early in the season would be indicated if the line were placed at 1.21 inches. It is seen from Figure 7 that late blight initiation and later destructive outbreaks coincide very well with the calculated favorable blight periods, except for the outbreaks late in the season at harvest time. Abundant inoculations during harvest operations may account for the late outbreaks.

Discussion

It might be argued that the 10-day rainfall method of forecasting blight is too conservative; that it would have forecast blight in 48 of the 52 years in Connecticut. The record shows, however, that blight was reported in 40 of the years. Also, in some years, blight would have been forecast for only part of the season. It is much safer to forecast blight and have none than to predict no blight but have it occur, especially if in any appreciable quantity. It is noteworthy that, with one possible exception, blight would always have been forecast in the years that it appeared. In 1949 it was reported along the coast (U. S. Plant Disease Survey, Warning Service Report No. 35). Infection was light and limited to the low areas in one field. It was not reported again from Connecticut and was first found in Massachusetts, in the Connecticut River Valley, on September 8. Thus it was thought more accurate, for forecasting purposes, to consider 1949 a nonblight year. It need hardly be emphasized again that an area forecasting system must apply to average conditions and not to atypical, isolated spots.

The prerequisite of 10 consecutive favorable days for blight to threaten applies to initial appearance of the disease. Once blight is present fewer favorable days are required for the fungus to sporulate and for new infections to result. This is quite clearly indicated by the data from Florida, where, once blight was present, new outbreaks occured within a few days after the weather turned favorable for the disease.

It might be argued that forecasts developed from past records, as is done here, are "hindsight." But the method used to determine favorable blight periods from past records is exactly the same as that used to predict them from current data. With current forecasts, however, it is true that recommended control measures would be influenced by the immediate weather forecast. The investigation of recorded facts that leads to generalizations through inductive reasoning is the scientific method through which most progress is made.

The advantage of basing a blight forecasting system on records of the Weather Bureau is obvious, since their records are collected from many places. Their use is not intended to cast doubt on the importance of high humidity and free moisture, from any source, on the foliage for increase of the disease. It is hoped that the use of rainfall and temperature records will lead to a very practical way of measuring the weather factors associated with epiphytotics of the disease.

The results presented suggest that the moving temperature-rainfall method may be successfully adapted to different climatic conditions. The probable reference rainfall line can best be determined as a line midway between those for the blight and nonblight years. Where blight records are not available it may closely approximate the average rainfall of the eastern United States coastal States.

Summary

An improved method has been developed for forecasting late blight of potato and tomato. The forecasts are based on an analysis of rainfall and temperature data by means of moving graphs.

Predictions for Connecticut would have been 83 percent correct in the 52-year period of 1902-53, inclusive. More important, blight would have been predicted every year that it occured.

Successfully predicted by this method would have been late blight of potato at Ithaca, New York, in 1928, and late blight of tomato on the west coast of Florida in 1945-46, when its occurrence was attributed to cool nights with heavy dew, and to long periods of high humidity, respectively.

It is concluded that the moving graph method might be successfully adapted to an extensive range of conditions.

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SURVEY FOR BROWN ROT OF STONE FRUITS IN CALIFORNIA

J. M. Ogawa, W. H. English, and E. E. Wilson

The first systematic survey of the brown-rot disease of stone-fruit trees in California was reported by Hewitt and Leach (3) in 1939. The causal fungi, Sclerotinia [Monilinia] fructicola and S. [M.] laxa, were found in all of the orchard districts surveyed, but the former was somewhat more widely distributed than the latter. Certain orchard districts were again surveyed by Barnett and Bodine (1, 2) in 1943 and 1944. We made limited surveys in 1948 and 1949, and followed these by extensive surveys in 1952 and 1953 in an attempt to determine if any important changes in the distribution of the two species has occurred.

The area from which collections were made included the major stone-fruit growing districts of California. In each county visited, an attempt was made to determine the status of brown rot on all species of stone-fruit hosts grown, including if possible, five orchards of each. The hosts checked were almond, apricot, cherry, peach, plum, prune, nectarine, and flowering quince.

The organisms were identified from their growth characteristics on 1.5% potato-dextrose agar as suggested by Hewitt and Leach (3). Sporulation characteristics of S. laxa at 4° C and sclerotia-like body formation of S. fructicola in tube cultures under laboratory conditions were also used as characters for species separation. In none of the cases was there a question as to the species concerned when the above techniques of identification were used.

Results

A limited survey during 1948 showed no major changes in host specificity or distribution of the pathogens on peach, apricot, or almond. However, on almond, S. fructicola was isolated from the almond hull in Contra Costa County for the first time. In the fall of 1953, hull infection by S. fructicola caused considerable damage in Butte County.

Direct infections of young apricot shoots by S. laxa were found extensively for the first time in the spring of 1953 in Yolo and Santa Clara Counties. The damage was very small.

Table 1. Summary of the Stone-fruit brown rot (Sclerotinia [Monilinia] spp.) survey made in California during 1952 and 1953.

Host	Number of orchards surveyed	Number of orchards with S. fructicola: Fruit	S. fructicola: Blossom and twig	S. laxa: Fruit	S. laxa: Blossom and twig	Percent of infected orchards with S. fructicola	Percent of infected orchards with S. laxa
Almond	71	3	4	0	27	21	79
Apricot	81	3	2	9	39	9	91
Cherry	29	11	5	2	1	84	16
Peach	112	35	10	1	3	92	8
Plum and prune	54	8	1	5	6	45	55
Nectarine	6	1	2	1	0	75	25
Flowering quince	10[a]	0	0	0	0	0	100

[a] Home gardens.

A summary of the survey during 1952 and 1953 is shown in Table 1, and maps showing the isolation records and the general area of fruit production are included for almond (Figure 1), apricot (Figure 2), and peach (Figure 3). The data in Table 1 show that S. laxa and S. fructicola were isolated from all of the stone-fruit species examined. From flowering quince, a pome fruit, only S. laxa was isolated. S. fructicola appears to be principally a fruit-rotting organism, with 72 percent of the isolations of this species coming from diseased fruits. On the other hand, 83 percent of the isolations of S. laxa came from blighted blossoms and twigs. S. laxa was isolated from 78 percent of the 109 blighted blossoms and twigs examined, whereas S. fructicola was obtained from 77 percent of the 79 diseased fruits collected.

Figure 1 shows that the brown-rot fungi are more prevalent on almonds in the northern and

FIGURE 1. Distribution of the brown-rot organisms on Prunus amygdalus in California. The heavy lines enclose the major areas of almond production.

FIGURE 2. Distribution of the brown-rot organisms on Prunus armeniaca in California. The heavy lines enclose the major areas of apricot production.

FIGURE 3. Distribution of the brown-rot organisms on Prunus persica in California. The heavy lines enclose the major areas of peach production.

central portions of the Sacramento-San Joaquin Valley than in the southern portions. Seventy-nine percent of the isolations from blighted blossoms and twigs of almonds, from 34 orchards, yielded S. laxa.

S. laxa also was isolated more frequently than S. fructicola from blighted blossoms and twigs of apricots (Figure 2). Both organisms were obtained from the San Joaquin and Santa Clara Valleys, but only S. laxa was isolated from Contra Costa, Solano, and Yolo Counties.

The survey of peach (Figure 3) shows that S. fructicola is the predominant species throughout the major producing areas. Ninety-two percent of the collection from 112 peach orchards gave S. fructicola, with fruit infection predominating.

Isolation records on cherry indicated that S. fructicola is the most common species in the cherry producing areas of California. S. laxa was obtained only once from Contra Costa, Santa Clara, and San Francisco Counties. Survey results on prune showed that from the San Joaquin Valley only a single culture of S. laxa was isolated, whereas both organisms were obtained from prunes growing in the Sacramento Valley. Only S. laxa was isolated from the prunes of the Santa Clara Valley. A survey of the plum orchards in Merced, Madera, Fresno, Tulare, Kern, and Placer Counties showed brown rot present only in Placer County, where both organisms were found. Six nectarine orchards examined in the Sacramento and San Joaquin Valleys gave both species of the pathogen.

Summary

The present survey indicates that no major change has occurred in the distribution of the brown-rot organisms in California since the survey of Hewitt and Leach. As in earlier surveys, both organisms were found in all the important stone-fruit districts of California. In addition, S. fructicola was found in Madera, Napa, and Solano Counties, and S. laxa was found in San Diego County. The fungi are still fairly specific with regard to host species and organs attacked. That is, S. fructicola is important primarily as a fruit-rotting organism of peach, and S. laxa is important primarily as a blossom- and twig-blighting organism on almonds and apricots. Specificity is much less pronounced, however, on cherries, plums, and prunes.

The stone-fruit species -- almond, apricot, peach, cherry, plum, prune, and nectarine -- are susceptible to both of the brown-rot fungi, but the relative abundance of the two organisms

on the different hosts varies considerably. From almond and apricot, S. laxa was isolated much more frequently than S. fructicola. From cherry, nectarine, and peach, S. fructicola was isolated most frequently. From prune and plum, the two organisms were obtained with approximately equal frequency, whereas from the flowering quince only S. laxa was obtained.

The infection of the hulls of almond by S. fructicola was first noticed in 1948 in Sutter County, and in the fall of 1953 a severe epidemic of hull infection by the same species occurred in Butte County. These infections resulted in the blighting of many spurs. Direct infections of young apricot shoots by S. laxa were found extensively in California for the first time in 1953.

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THE "ECKELRADER" DISEASE OR "PFEFFINGERKRANKHEIT" DETECTED IN CHERRY IMPORTATIONS FROM EUROPE

J. A. Milbrath

In 1949, a program of assembling all of the known varieties of sweet and sour cherries to test for resistance to the little cherry and albino viruses was initiated at Oregon State College. The possibility of the introduction of virus diseases new to the State of Oregon was realized, but the program warranted the risk. All varieties were indexed on Prunus serrulata variety Shirofugen, for ringspot, and on Bing sweet cherry for other serious virus diseases. Although these two hosts were suitable for detecting only part of the stone-fruit viruses, the problem of indexing over 300 varieties and selections was too great to make complete index tests. Bing was selected as an index plant because symptoms of most of our known stone-fruit viruses are expressed on that variety. The results obtained by indexing for ringspot on Shirofugen have already been reported (3). Since ringspot is generally distributed throughout our sweet and sour cherry orchards, further introduction of ringspot did not offer any serious problem.

All cherry importations were obtained through the plant introduction station located at Chico, California. Two separate introductions, when indexed on Bing, were found infected with a virus not previously known to exist in the United States. The symptoms of the disease appear very similar to the "Pfeffingerkrankheit" described by Blumer (2) from Switzerland or the "Eckelrader disease" described by Mulder (4) from Holland.

Prunus avium, variety Esperen (P.I. 127371), originally from France, was grafted onto a Bing tree in March, 1949. On July 7, 1950 one of the scions and some of the adjacent Bing branches bore leaves which were conspicuously narrow and had a roughened surface (Fig. 1, 2) similar to that often associated with the deep-suture disease (1, page 202). Terminal growth was shortened, and the foliage of the branches appeared to be rosetted. The disease condition continued to spread through the Bing branches, and the presence of a virus disease was indicated.

Buds were taken from the diseased branches of the Bing trees and placed in branches of six-year old Bing and Napoleon trees. Again, the symptoms first showed one year later in a branch of the inoculated Bing tree, and two years later, one-third of the tree was affected. Three years after inoculation, nearly every leaf on the inoculated tree was affected. The Napoleon variety appeared more tolerant to the virus, and only an occasional leaf on terminals developed symptoms, or an occasional leaf in a fruit spur would be small and twisted. A few leaves with numerous enations in addition to other deformities were noted on a few terminals of the inoculated Bing branch, but for the most part, enations were not generally present on affected leaves. The "oil spot" mottles described by Blumer and Mulder were not observed at any time. In general, the other symptoms produced on Bing clearly resembled those illustrated by Blumer (1) and Mulder (4).

This disease resembles rasp leaf (1, page 133) in the reduction of size of leaves and severe effect on growth habit, and Mulder (4) suggests a possible relationship. The two diseases were compared on Bing trees and found to differ greatly on this variety. Rasp leaf produces numerous enations on nearly every affected Bing leaf, and the rate of movement of the causal virus through the tree is very slow. Three years after inoculation with rasp leaf virus, the leaves beyond a radius of two feet were unaffected, while in a similar time, the entire tree was affected with the introduced virus.

Prunus cerasus var. umbraculifera, originally obtained by the Chico Station from the Arnold Arboretum in 1939, and then assigned P.I. number 133841, was also grafted onto Bing; a disease similar to the one described for P.I. 127371 developed on the adjacent Bing foliage. The symptoms developed less rapidly on this latter tree and were not so severe, but in general would be classified as the same disease.

All introduced sources of these two cherry varieties at the Chico Station and all subsequent propagations from them have been destroyed.

These results illustrate how one can innocently introduce plant viruses in symptomless varieties and species, and thus demonstrate that visual inspection, even of growing material, is not sufficient for detection. The results further emphasize the need for systematized indexing of imported vegetative plant materials before they are released for propagation.

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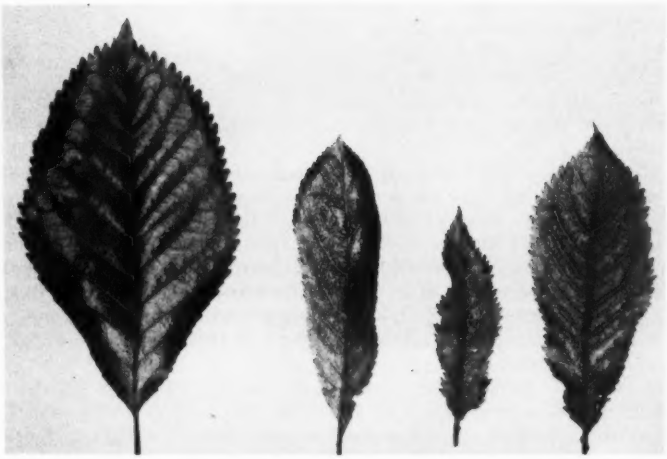

FIGURE 1. Leaves from an inoculated Bing tree showing the reduction in size, alteration in shape, and roughening of the leaf surface. A normal Bing leaf on the left for comparison. (Photographs by H. H. Millsap)

FIGURE 2. Terminal branch from inoculated Bing tree showing the uniformity of virus effect. A normal Bing leaf on right for comparison.

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RINGSPOT -- A VIRUS DISEASE OF CULTIVATED BLUEBERRY

M. T. Hutchinson[1] and E. H. Varney[2]

A disease of the cultivated highbush blueberry (Vaccinium corymbosum L.), known locally as "ringspot," has been observed for several years in a number of commercial blueberry fields in New Jersey. The Cabot variety is the principal one affected, although symptoms have been noted occasionally on Pioneer blueberry.

Symptoms are suggestive of other described ringspot diseases caused by viruses. They are most apparent in the fall when affected leaves may show red rings, and/or jagged patterns of the oak-leaf type associated with the veins (Fig. 1). In the spring, small red circles and dots may be seen on the leaves. These are not always found on infected bushes, however, and even when present they may be unnoticed. In grafting experiments, small chlorotic dots were the first symptoms of ringspot. These later changed to red dots, after which red rings and the characteristic oak-leaf patterns appeared. Diagnostic rings may be present on the stems throughout the year (Fig. 2). Occasional blueberry plants that show symptoms of the stunt virus disease[3] in addition to symptoms of ringspot have been found.

Ringspot was transmitted to 10 of 13 two-year-old Cabot plants whip-grafted in April, 1952. Clear symptoms were evident within five months. In 2 of the 10 transmissions, scion and stock did not make permanent union. With 1 possible exception, 40 non-grafted Cabot plants maintained as checks remained free of symptoms.

Spread of the disease is rather rapid in the field. An interplanted block, one variety per row, of Pioneer, Rubel, Concord, Rancocas, and Cabot blueberries was mapped for three years. About 3,000 of the 10,000 bushes in this planting were of the Cabot variety, mostly concentrated in the southerly portion of the field. Symptoms were observed regularly on Cabot only and occasionally on Pioneer. Disease incidence for Cabot was 121 plants in 1950, 232 plants in 1951, and 383 plants in 1953 (Fig. 3). It has not yet been determined whether plants of the other varieties in this block may be symptomless carriers. No insect vector has yet been discovered.

Data are not available with regard to the effect of ringspot on blueberry production. Affected bushes, however, appear to continue to set fruit. Cabot is no longer an important variety in New Jersey.

Blueberry ringspot is considered to be a virus disease because of the virus-like symptoms, the nature of spread in the field, and the fact that it is graft-transmissible.

COOPERATIVE INVESTIGATIONS BETWEEN THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION AND SECTION OF FRUIT AND NUT CROPS AND DISEASES, HORTICULTURAL CROPS RESEARCH BRANCH, UNITED STATES DEPARTMENT OF AGRICULTURE

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FIGURE 1. Fall symptoms of ringspot on Cabot blueberry leaves. Leaf showing ring patterns (inset).

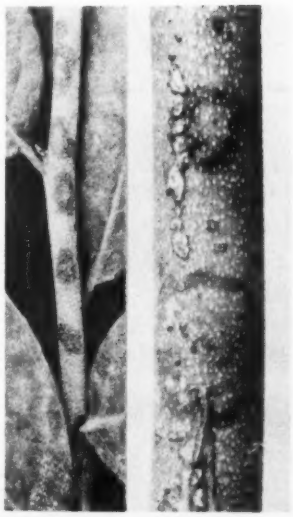

FIGURE 2. Ringspot symptoms on stems of Cabot blueberry. Left: in September; right: in December.

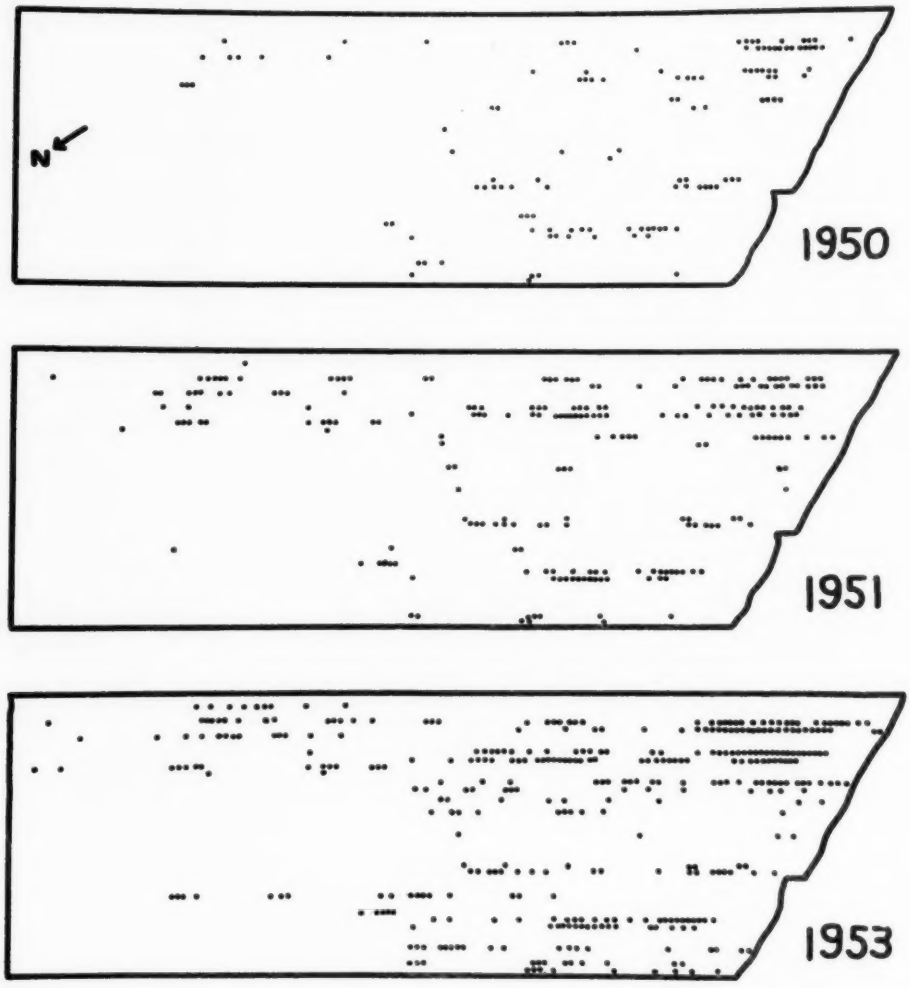

FIGURE 3. Spread of blueberry ringspot in an 8-acre field near Chatsworth, New Jersey. Each dot represents a diseased Cabot blueberry.

TOBACCO-NECROSIS VIRUS ON LETTUCE

C. E. Yarwood

The report by Fry (1) that tobacco-necrosis virus was commonly associated with lettuce big vein in New Zealand suggested a similar study in California, where big vein is an important disease but where tobacco-necrosis virus has apparently not been reported on any field crop. Roots of big-vein and of normal lettuce plants from fields showing big vein in the San Pablo and Salinas areas were ground in water, 0.5% K_2HPO_4 added, and the mixture was rubbed on primary leaves of cowpea and Pinto bean. Lesions similar to those formed in the same trials by Fulton's (2) A strain of tobacco-necrosis virus were formed from inocula from some healthy and some big-vein plants. In addition some much smaller lesions and some much slower to appear than those formed by Fulton's tobacco-necrosis virus were formed in certain cases. While tobacco-necrosis virus-like lesions appeared more frequently from plants showing big vein than from healthy plants, a causal relation between tobacco-necrosis virus and lettuce big vein has not been established. Inoculations of cowpeas with juice from greenhouse lettuce plants inoculated with juice from lettuce plants have yielded lesions on cowpea more frequently when the lettuce plants showed big vein than when they did not. The numbers of tobacco-necrosis virus-like lesions of cowpea resulting from inoculation with juice from lettuce or other roots was very erratic between different plants in the same test and between the same plants in different tests, and the method of assay may not be highly satisfactory.

Inoculations of tomato roots with Fulton's strain of tobacco-necrosis virus yielded a big-vein or vein-clearing symptom on the lower leaves of eight out of eight inoculated plants and two out of eight uninoculated control plants in one trial, but no such symptoms resulted in three other trials.

These results appear to establish for California a situation with respect to tobacco-necrosis virus and lettuce big vein similar to that described by Fry in New Zealand.

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HOST RANGE OF CHLOROTIC STREAK DISEASE OF SUGAR CANE[1]

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Chlorotic streak is an important disease of sugar cane in Puerto Rico (2) where it is particularly abundant in humid regions on wet soils. At present the only recommended means of combatting the disease in Puerto Rico are the selection of healthy seed, or the treatment of seed cane with hot water at 52° C for 20 minutes. Varieties known to be resistant or tolerant are not otherwise commercially adaptable to Puerto Rico conditions. From the standpoint of long-range control it would be desirable to discover resistant varieties or develop them through the breeding program. In an attempt to discover resistant varieties the sugar cane breeding nursery at Rio Piedras, which was on low, humid lands and was in its fifth ratoon, was inspected for chlorotic streak.

Elongate, chlorotic leaf lesions with a diffuse wavy margin and occasional necrotic areas, which are the principal symptoms, were taken as the criteria for this disease. Infection in the breeding nursery was light but widespread. Some varieties known to be susceptible were healthy, so that the absence of symptoms did not necessarily indicate resistance. Results of observations on incidence of the disease in the nursery and elsewhere in Puerto Rico are in Table 1.

Even though these observations add Panicum and Erianthus as hosts, and Pennisetum has been reported previously (1), it is believed that the host range is in reality quite limited as no symptoms were observed in the many other grasses in and around infected cane fields. Representatives of Saccharum officinarum and S. edule examined showed very little infection, while S. spontaneum had the largest proportion of infected varieties. These observations are similar to those of Wilbrink (4) in that they incriminate S. spontaneum as a source of susceptibility. This is important since breeding programs in some countries rely on representatives of this species as a source of vigor and of resistance to other diseases. Wilbrink did not observe infection on noble canes or Chunnee descendants (Chunnee, Imp. 233, was apparently healthy in the Rio Piedras nursery), but in Formosa Chunnee and its hybrids, Badila and its hybrids, and hybrids with S. robustum, Miscanthus, and sorghum were susceptible (3). In Hawaii and Australia both noble and hybrid canes are attacked. In field tests in Louisiana[2] no grasses other than Saccharum spp. have been observed infected with chlorotic streak. The apparent discrepancies in host range as now reported in the literature lead to the speculation that there may be strains of this virus with different host ranges.

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[1] Cooperative investigations between the U. S. Department of Agriculture, Agricultural Research Service, and the University of Puerto Rico Agricultural Experiment Station.

[2] Abbott, E. V., U. S. Sugar Plant Field Station, Houma, by correspondence.

Table 1. Sugar cane and grasses observed with chlorotic streak symptoms in Puerto Rico, October 1952 to May, 1953.

Species	Number of varieties observed	Number of varieties with symptoms	Varieties with symptoms
Saccharum officinarum[a]	25	3	Green Ribbon, 31[b]; Loethers, 723; BH 10(12) in commercial fields
S. spontaneum	15	10	Burma, 848; G. Kepandjen (very susceptible), 558; India, 470; Local, 238; Djatiroto, 569; Kloet, 564; Narenga, 229; Tabongo 578; Pasoeroean, 555; unknown, in another nursery[c]
S. sinense	11	4	Kinar, 6; Tekcha, 62; Merthi (Zell), 150; Uba, in relict stools in commercial fields
S. barberi	3	1	Hemja, 234
S. robustum	8	1	New Hebrides 1, 933
S. edule	5	0	
Erianthus arundinaceus	1	1	28 New Guinea 7, 631[c]
E. maximus	2	2	New Caledonia 132, 921[c]; Raiatea 1.
Erianthus sp.	1	1	Unknown, in another nursery
Panicum maximum	Several lines and intraspecific crosses[c]		
Pennisetum purpureum	Several lines and hybrids of P. purpureum with P. glaucum[c]		

Unknowns - S. N. S. Bahrui, 141; and New Hebrides 2.

[a] Symptoms have also been found on all commercial cane varieties observed to any extent in the field. These commercial canes with the exception of BH 10(12) are complex interspecific hybrids.

[b] Importation number of the Division of Sugar Plant Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Dept. of Agriculture.

[c] Stem cuttings of diseased canes were made. Hot water treatment gave healthy plants while some plants from untreated cuttings developed symptoms of chlorotic streak.

THE EFFECT OF SOIL-BORNE WHEAT MOSAIC ON YIELD OF WINTER WHEAT

Wayne M. Bever and J. W. Pendleton[1]

In past years many tests have been made on the effect of the soil-borne mosaic on the yield of winter wheat. In 1953, Wadsworth and Young[3] and in 1954, Roane, Starling, and McKinney[2] compared yields of a number of wheat varieties when grown in mosaic-free soil and soil infested with the soil-borne wheat mosaic virus. In Illinois, previous to this time, however, all tests have compared the yield of a mosaic-resistant variety with that of a mosaic-susceptible variety when grown in a soil heavily infested with the soil-borne wheat mosaic virus.

In 1953, the winter wheat variety trials on the Agronomy South Farm at Urbana, Illinois, afforded an excellent opportunity to compare the yields of each variety grown on a noninfested and infested area. Four replications of 1/75-acre plots each, of 25 varieties or strains, were grown on each area. The infested and noninfested areas were separated by a grass waterway approximately 40 feet wide. Susceptible varieties showed no symptoms on the noninfested area, while the same varieties grown on the infested area showed symptoms ranging from mild mottling to severe rosette according to the susceptibility of the variety. Yields were calculated on the basis of individual plots from each area.

The comparative yields and the percentage of mosaic and type of symptoms are given in Table 1. The varieties are grouped according to the type of symptom produced (Table 1). This is not always easily accomplished because under certain environmental conditions, varieties such as Blackhawk, Pawnee, Ponca, and Triumph will outgrow the symptoms and the effects are difficult to ascertain at maturity. However, the 1953 season was dry and the above-named varieties failed to recover from the severe mottling effects of the virus infection.

In comparing the effects of different types of mosaic symptoms on the percentage loss in yield, there is a significant difference at the 5 percent level between those showing mild mottle and those showing severe mottle. No formal statistical measures of significance are necessary to show the differences in percentage loss between the varieties showing the rosette type of symptom and the mild mottle or severe mottle type.

The yield differences in Table 1 are believed to be due largely to virus infection. There was little evidence of other diseases being present and the fertility level of the two areas is similar. The yields of four varieties (Knox, Prairie, Purdue C.I. 12985, and Westar) were slightly but not significantly higher on the infested area than on the mosaic-free area.

The large differences in yield between the two areas in the varieties, Illinois 45-501, Royal, Saline, Seneca, and Turkey (Sta.) are not explained.

COOPERATIVE INVESTIGATIONS OF FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, U. S. DEPARTMENT OF AGRICULTURE, AND THE ILLINOIS AGRICULTURAL EXPERIMENT STATION

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[1]Agent (Pathologist), Field Crops Research Branch, and Professor, Crop Pathology, and First Assistant, Department of Agronomy, University of Illinois.

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Table 1. A comparison in yield of 25 winter wheat varieties and strains when grown in non-infested soil and soil infested with the soil-borne wheat mosaic virus at Urbana, Illinois. 1953.

Variety	C.I.[a] No.	Yield			Percent of diseased plants in mosaic-infested areas[b]		
		Mosaic-free area (bu./A.	Mosaic-infested area (bu./A.)	Percent yield loss	Mild mottle	Severe mottle	Rosette
Butler	12527	35.4	33.5	5.37	20	0	0
Fairfield	12013	31.7	30.0	5.36	20	0	0
Ill. 43-102	-----	35.7	35.2	1.40	10	0	0
Ill. 43-113	-----	37.0	35.6	3.78	10	0	0
Ill. 45-501	-----	39.0	34.0	12.82	10	0	0
Knox	12798	38.8	39.2	-----	10	0	0
Prairie	12069	35.6	37.7	-----	20	0	0
Purdue	12557	37.8	36.0	4.76	30	0	0
Purdue	12985	33.9	34.1	-----	25	0	0
Royal	12558	33.7	28.1	16.62	20	0	0
Saline	12674	38.1	31.2	18.11	10	0	0
Seneca	12529	37.4	28.9	22.72	25	0	0
Turkey (Sta.)	-----	37.3	32.4	13.14	10	0	0
Vigo	12220	30.2	28.1	6.95	20	0	0
Westar	12110	39.3	44.3	-----	20	0	0
			Mean percent loss	10.83			
Blackhawk	12218	33.8	27.3	19.23	0	75	0
Early Pawnee	-----	37.5	31.6	15.73	0	90	0
Iohardi	12510	35.2	26.1	25.85	0	96	0
Pawnee	11669	41.2	34.1	17.23	0	92	0
Ponca	12128	36.9	32.2	12.74	0	95	0
Turkey (Bach)	-----	35.0	28.9	17.43	0	65	0
Triumph	12132	38.2	30.6	19.89	0	96	0
Wichita	11952	40.5	32.3	20.25	0	85	0
			Mean percent loss	18.54			
Kiowa	12133	38.2	5.7	85.08	0	2	96
Stafford	12706	40.7	9.6	76.41	0	2	97
			Mean percent loss	80.74			
			LSD .05 =	7.1			
			LSD .01 =	9.7			

[a] C.I. refers to accession number of the Section of Cereal Crops and Diseases.

[b] Mild mottle: leaves slightly mottled with no stunting of plants. Mottling disappeared before heading. Severe mottle: plants severely stunted, extreme mottling. Infected plants did not recover. Rosette: typical rosetting of plants with most of the infected plants dying even though there was no killing as result of low winter tempeatures.

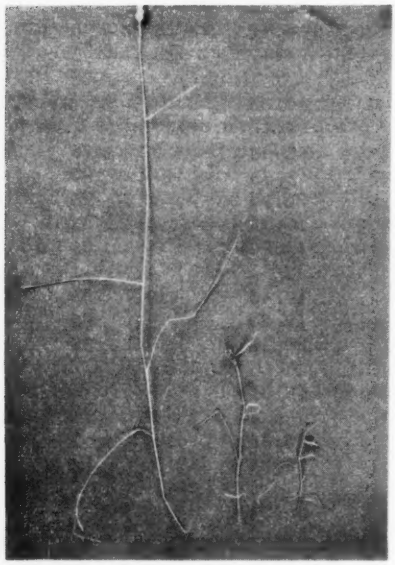
A NOTE ON THE LONGEVITY OF THE WHEAT NEMATODE, ANGUINA TRITICI STEINBUCH[1]

J. M. Raeder[2]

Sometime during 1939, a specimen of wheat nematode galls collected at Pulaski, Virginia, was received by the writer for instructional purposes. The correspondence concerning the transaction has long since been discarded. In the interim the specimen has been stored in a cork-stoppered bottle on a shelf in the Plant Pathology laboratory of the University of Idaho.

On November 12, 1952, a few of the galls were macerated in water in a watch glass to show the worms to students in a course in field-crop diseases. Upon examination the following day, many of the worms showed considerable activity. After a period of dessication, water was again added to the watch glass on January 20, 1953. The next day the worms again showed activity. The specimen was again allowed to dry out. On February 25, 1953, water was again added to the container in the morning. By afternoon, a few of the worms were again active. This would prove that the worms had remained viable for 14 years.

To test further the viability of the nemas in the stored galls, a number of the galls were macerated in water which was allowed to stand overnight and then poured on pasteurized soil in two pots seeded with Lemhi and Marquis wheat respectively. This was done February 25, 1953. During the growth of the plants, no distortion in growth habits as depicted by Byers (1) was noted. However, when the grain was mature, May 28, 1953, five heads out of a total of the 46 of the Lemhi showed unmistakable evidence of the presence of galls (Figs. 1 and 2). Ten out of a total



HEALTHY DISEASED

FIG. 1

FIGURE 1. Healthy culm and head on left. Two infected plants on right.

HEALTHY DISEASED

FIG. 2

FIGURE 2. Healthy kernels on left. Nematode galls on right.

[1] Published with the approval of the Director as Research Paper No. 374 of the Idaho Agricultural Experiment Station.

[2] Associate Plant Pathologist, Idaho Agricultural Experiment Station, Moscow, Idaho.

of 42 heads of Marquis showed the presence of galls. All culms bearing infected heads were noticeably stunted and still slightly green. One culm of Lemhi about 6 inches tall was badly distorted. The average height of the healthy culms varied from 18 to 30 inches. Microscopic examination of a macerated, newly developed gall showed the contents of the gall to be made up of innumerable active worms. Identification of the nemas in the galls was made by Dr. Gerald Thorne, U. S. Department of Agriculture, Agricultural Research Service.

Needham (5) made the statement in 1775 that Baker observed movement in larvae from galls stored 27 years. Leukel (4) suggests that this movement which Baker observed may have been merely a mechanical straightening of dead larvae when they were placed in water. Goodey (3) states that the worms cannot live longer than 10 years. Fielding (2) offers proof that the nemas will live for 28 years. This would indicate that the mobility of the worms observed by Baker could have been true motion, rather than a mechanical straightening of dead worms. No one has offered evidence to prove that nemas, although active after long periods of dormancy, still retain the ability to infect wheat. The data presented herewith prove that the wheat nematode, Anguina tritici, can retain its viability and its capacity to infect wheat after 14 years of dormancy

On November 16, 1953 several more galls from the original specimen were macerated in water. Movement of the worms was noted on November 19, 1953. This extends the viability of the worms of the original specimen to 15 years.

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IDAHO AGRICULTURAL EXPERIMENT STATION, MOSCOW

DRYLAND ROOT ROT COMPLEX OF WINTER WHEAT IN EASTERN NEW MEXICO[1]

C. H. Hsi[2]

The widespread occurrence of the dry-land root rot of wheat in eastern New Mexico in 1953 was the result of the complementrary effect of: 1) environmental conditions conducive to the development of the disease, 2) susceptibility of all commercial varieties grown in the area, and 3) abundance of root-rot organisms in the soil.

Previous studies (2, 3, 5, 6, 7, 10, 11) have indicated a generally close association of root-rot severity with unfavorable growing conditions for wheat plants, such as high temperatures and low soil moisture. On the basis of such information, conditions in eastern New Mexico which predisposed host plants to attack by root rot organisms were 1) early fall planting in 1952 when air and soil temperatures were still high, 2) much depleted sub-soil storage moisture as a result of low precipitation in the year preceding the growing season, and 3) severe drought during most of the 1952-53 wheat-growing season. Pertinent weather data from several representative locations in the major winter wheat area of eastern New Mexico are given in Tables 1 and 2. Table 1 shows maximum, minimum, average, and extreme temperatures for the planting months August and September 1952. Table 2 shows monthly precipitation totals from July, 1952 through June 1953, and annual totals for 12 months preceding this period.

Common commercial wheats such as Comanche, Blackhull, Turkey, Chiefkan, Apache, Cheyenne and others were all susceptible to the root-rot complex. No attempt was made to determine the degree of susceptibility of the various varieties surveyed.

Some of the more common fungi involved in this disease complex as determined by previous investigators are Helminthosporium sativum (1, 2, 7, 9, 12, 16, 17, 18), Curvularia spp. (7, 9, 10), Fusarium spp. (7, 12, 16, 17), Rhizoctonia solani (7, 8, 12, 16, 17, 18), and Alternaria spp. (1, 7, 18). Frequency of occurrence of these fungi in four survey areas of eastern New Mexico (Fig. 1) and in every month from February to July, 1953, is listed in Tables 3 and 4 respectively. H. sativum was most commonly isolated from the rotted roots and was the only fungus constantly isolated in the six-month period.

The symptoms of dryland root rot have been described in considerable detail by previous investigators (1, 4, 7, 12, 15, 16, 17). The symptoms most frequently observed on the poor wheat of eastern New Mexico in 1953 were varying degrees of black-, brown-, tan-, or pink-colored lesions or general blighted appearance of the crowns, mostly subcrown internodes, roots, and basal leaf sheaths.

Because of the acute moisture situation, the crown roots were very poor in development and few in number. This observation corresponds rather closely with that made in semi-arid retions of western Canada by Simmonds and Sallans (14). The combination of the poor crown-root growth and the severe lesion at the subcrown internode which cuts off the entire lower root system may reduce the yield of wheat plants 30 to 45 percent (13). In adverse years, such as the past one in eastern New Mexico, this combination may often be the difference between complete and partial failure of wheat production.

Isolates of H. sativum collected at different localities in eastern New Mexico varied considerably in morphological and cultural characters when they were grown on the same medium under the same conditions. Some isolates obtained from the same locality, but at different times of the year, appeared similar on the same medium. However, isolation of two or more biotypes of this fungus from the same area was not uncommon. Some consistency of isolates in one locality, among with variability of isolates in different localities, seems to indicate that the root-rot disease in eastern New Mexico is largely soil-borne.

SUMMARY: The widespread occurrence of dryland root-rot of winter wheat in eastern New Mexico in 1953 was caused by 1) environmental conditions conducive to the disease development, 2) susceptibility of commercial varieties grown in the area, and 3) abundance of root-rot organisms in the soil.

The fungus Helminthosporium sativum was most frequently isolated from the diseased roots. It is the only fungus constantly isolated in the six-month period from February to July, 1953.

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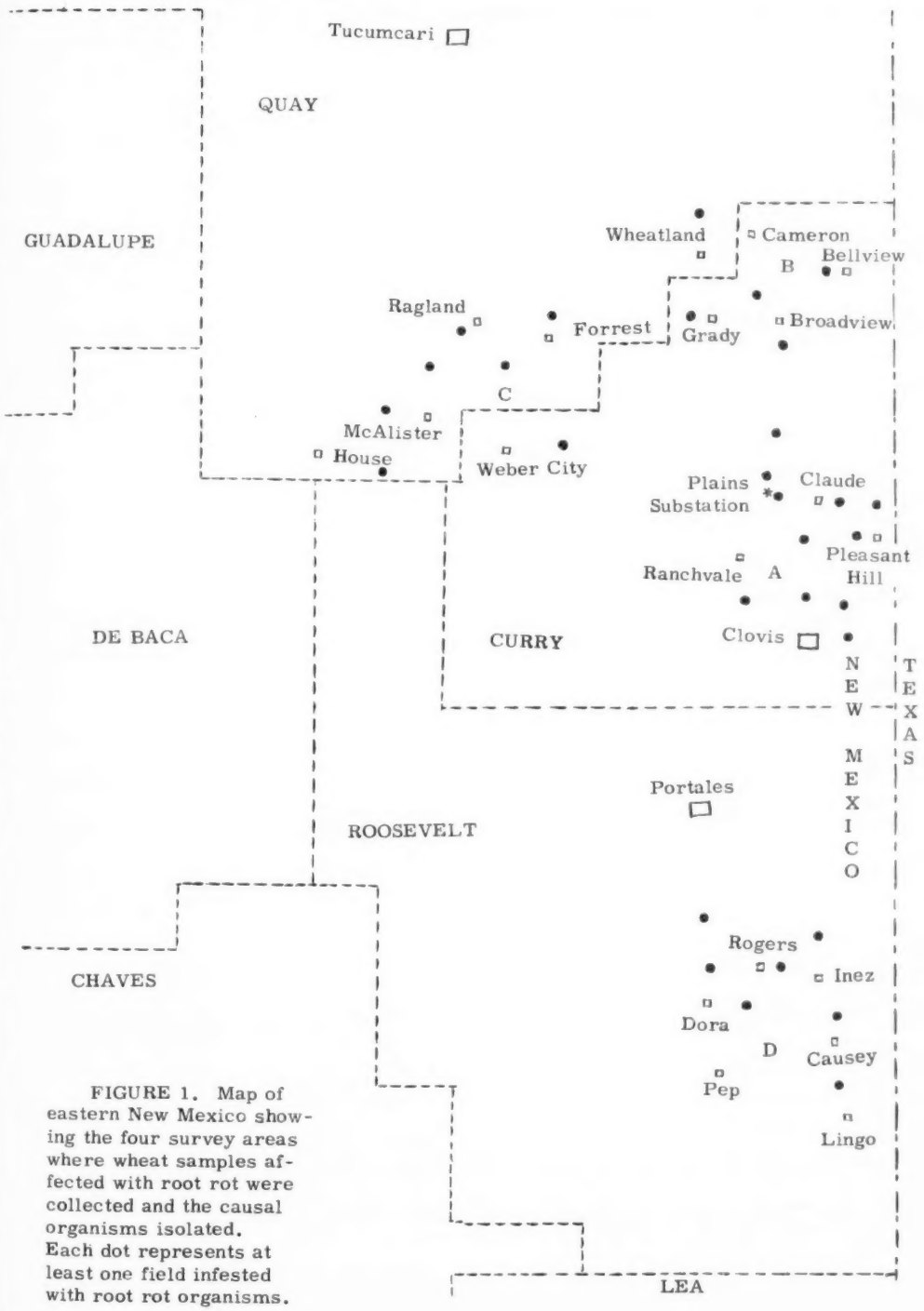

FIGURE 1. Map of eastern New Mexico showing the four survey areas where wheat samples affected with root rot were collected and the causal organisms isolated. Each dot represents at least one field infested with root rot organisms.

Table 1. The maximum, minimum, average, highest, and lowest temperatures recorded at four weather stations in eastern New Mexico for the wheat-planting months August and September, 1952.

Weather stations	1952 Temperatures (°F.)									
	August					September				
	Average maximum	Average minimum	Average	Highest	Lowest	Average maximum	Average minimum	Average	Highest	Lowest
Cameron	94.3	60.2	77.3	99	54	81.7	51.4	66.6	92	42
Clovis	94.0	64.7	79.4	101	59	82.7	52.3	67.5	95	45
Plains Substation	93.6	62.9	78.3	99	59	82.3	52.3	67.3	94	46
Pep	94.2	62.7	78.5	102	56	83.4	50.7	67.1	95	45

Table 2. Annual precipitation from July, 1951 to June, 1952, and monthly precipitation from July, 1952 to June, 1953, recorded at six weather stations in the New Mexico plains area.

Weather stations	Annual precipitation (inches) July, '51 June, '52	Monthly precipitation 1952-53 (icnhes)												
		July	August	September	October	November	December	January	February	March	April	May	June	Total
Arch	9.38	2.08	1.16	.82	--	.66	.50	.45	.12	.82	.39	1.74	--	8.74
Cameron	7.30	2.48	1.29	.69	--	1.21	.54	.50	.29	.14	.27	1.05	.19	8.65
Clovis	12.61	2.18	1.00	.85	--	1.25	.40	.68	.29	.71	1.09	1.09	.03	9.57
Plains Substation	13.13	.59	1.33	.84	--	1.28	.59	.57	.27	.61	.29	.29	.08	7.38
Forrest	7.43	4.49	2.19	.88	--	1.41	.24	.11	.54	.06	.52	.52	.28	11.15
Pep	8.91	1.27	2.30	.90	--	.57	.40	.54	.10	.79	.40	.40	.01	8.32

Isolates of H. sativum collected in eastern New Mexico varied greatly in morphological and cultural characters on the same medium under the same conditions. The root-rot disease in New Mexico is probably largely soil-borne, as indicated by some consistency of isolates collected from the same locality at different times of the year.

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Table 3. Fungi isolated from wheat samples affected with root rot in fields of four survey areas of eastern New Mexico.

Fungus	Number of fields from which fungus was isolated				
	Area A	Area B	Area C	Area D	Total
Helminthosporium sativum	14	8	7	12	41
Curvularia spp.	3	3		2	8
Fusarium spp.	9	2	4	5	20
Rhizoctonia solani	5	4	2	3	14
Alternaria spp.	3	1		1	5
Total	34	18	13	23	88

Table 4. Fungi isolated from wheat samples affected with root rot in eastern New Mexico from February to July, 1953.

Fungus	Number of fields from which fungus was isolated						
	Feb.	March	April	May	June	July	Total
Helminthosporium sativum	6	3	7	9	8	8	41
Curvularia spp.			3	2	3		8
Fusarium spp.	5	5	9	1			20
Rhizoctonia spp.	2	2	5	3	2		14
Alternaria spp.	2			1	2		5
Total	15	10	24	16	15	8	88

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NEW MEXICO AGRICULTURAL EXPERIMENT STATION, PLAINS SUBSTATION, CLOVIS

SPIKELET-DROP OF OATS

S. S. Ivanoff

This writer has observed an apparently unreported diseased condition of oats, characterized chiefly by necrosis of the rachillae and the subsequent dropping-off of individual spikelets.

This condition was noted for some time before any significance was attached to it[1]. In the spring of 1952, spikelet-drop was found in a pronounced form in two isolated plantings of oats on the grounds of the South Mississippi Branch Experiment Station at Poplarville. These plantings were made for the purpose of seed increases of two new strains of oats combining crown-rust and Victoria-blight resistance, derived from Winter Turf x Santa Fe, and Appler x Landhafer, respectively. The spikelet-drop condition was conspicuous because of the large number of spikelets seen on the ground. At that time it was thought that perhaps the significant extent of this condition might be attributed to the genetic constitution of these two strains. In the same season, however, the same condition was observed on several commercial varieties of oats at McNeil, Mississippi, in a standard oat variety test.

FIGURE 1. A spike of oats showing the expression of the spikelet-drop condition described. Note the right-angle bend of the rachilla of the topmost spikelet, also the similar bends at the lower right portion of the spike. In the fresh condition the affected spikelets were yellowish green to tan, the rest of the spike green.

Some of the detached spikelets, shown at the bottom, contained kernels consisting mostly of hulls and glumes; others did not. Apparently they dropped off before the kernels were formed.

The symptoms in detail were as follows: The uppermost spikelets attracted attention first by their discolored appearance in plants that had not yet reached the period of maturation. The outer glumes enveloping the two kernels in a spikelet were a pale green to tan color in contrast

[1] Recently Dr. Douglas C. Bain, plant pathologist of this Station, has informed the writer that he had observed the same or a similar condition on oats in the Mississippi Delta in 1944.

to the still normal green of the rest of the spike. Conspicuous also were the discoloration and the direction of the rachillae near the base of the spikelet. The affected rachillae were bent to form a right angle, or nearly so (Fig. 1). They were also very brittle on account of the necrosis at the bent portion of each of them. This brittleness seemed to be the direct cause for the dropping of the spikelet. When a bent rachilla was touched with the finger it broke off easily and the spikelet dropped to the ground. Closer examination showed that other spikelets situated on the lower portions of the spike were similarly affected. Some of these had withered and dropped to the ground before grain had formed. In some instances it was observed that some spikes had lost as much as 10 percent of the grain.

Specimens were examined microscopically. Dark hyphae were found in the tissue of the rachillae but there were no spores. No further studies were made of this condition in that year, as the condition was still considered of occasional importance.

In July 1953 diseased oat specimens received from the County Agent of Newton County and from the Mississippi Coastal Plains Branch Experiment Station workers showed symptoms similar to those described above, but in a much more severe form. Some of the spikes had only an occasional spikelet left, the rest had dropped off. It was stated that the oat harvest from three different fields on three different farms resulted in complete failure. A visit was made to each of these farms. Most of the crop was already cut, supposedly for grain, but no grain was collected. Many plants were found still standing near the edges of the fields. The rachillae showed the same discoloration, bending, and brittleness as previously described, but this time they were covered with a black fungus growth particularly at the abnormal bend of the rachillae. Conidia of a species of Helminthosporium were present, borne on conidiophores which, in turn, were connected with the dark mycelium of the fungus within the tissue. The outer glumes were also covered by blotches of the same growth. The roots of these plants were almost completely decayed.

What other diseases, if any, affected this crop was difficult to determine at that time.

It was stated that the seed source of these three plantings was the same. This suggested, although not conclusively, that the trouble may have been seed-borne. All three fields were planted late and side-dressed with ammonium nitrate in early Spring.

It is difficult for this writer to state at this juncture whether this "spikelet-drop" is a new disease, or a little-observed symptom of an old disease.

Further investigation is in progress.

DEPARTMENT OF PLANT PATHOLOGY AND PHYSIOLOGY, MISSISSIPPI AGRICULTURAL EXPERIMENT STATION, STATE COLLEGE, MISSISSIPPI

GRASS DISEASES ON NEW HOSTS IN THE PULLMAN NURSERY UNIT OF THE SOIL CONSERVATION NURSERIES

Jack P. Meiners

Detailed inspections for diseases were made during June, 1953 in the Observational Nursery of the Pullman Unit of the Soil Conservation Nurseries located at Pullman, Washington.

Numerous accessions of native and introduced species of grasses are grown side by side in this nursery, so that an excellent opportunity is presented to compare accessions and species, not only for agronomic characteristics, but also for disease reaction providing conditions are favorable for disease development.

In 1953 disease development was favored by a relatively mild winter followed by a cool, wet spring and early summer. By June, heavy infestations of foliar diseases were noticeable. At that time row by row examination of the grasses in the nursery disclosed the presence of several pathogens on hosts on which they have not previously been reported (2), as follows:

STRIPE RUST (Puccinia glumarum (Schm.) Eriks. & E. Henn.)
Agropyron amurense Drobov.[1]
A. mongolicum Keng.
A. scabraglume (Hackel) L. Parodi
A. trichophorum (Lk.)Richt.
Elymus chinensis (Trin.) Keng.
E. dahuricus Turcz.

LEAF RUST (Puccinia poae-sudeticae (West.) Jørst.)
Alopecurus arundinaceus Poir.

SCALD (Rhynchosporium orthosporum Caldwell)
Alopecurus arundinaceus[2]
Lolium remotum Schrank.

SCALD (Rhynchosporium secalis (Oud.) J. J. Davis)
Agropryon desertorum (Fisch.) Schult.
A. riparium Schribn. & Smith
A. scabraglume
Elymus angustus Trin.
E. chinensis

LEAF STREAK (Scolecotrichum graminis Fckl.)
Agropyron trichophorum

BLAST (Spermospora subulata (Sprague) Sprague)
Bromus marginatus Nees.

In addition to the new host records, an eyespot associated with Selenophoma donacis var. stomaticola (Bauml.) Sprague & A. G. Johnson was found on Arrhenatherum elatius (L.) Beauv. in the State of Washington for the first time.

The writer is indebted to Mr. Edward A. Minnick, of the Soil Conservation Service for assistance in taking disease notes, and in identification of hosts.

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[1] There is some question as to whether true A. amurense Drobov. has been introduced into the United States.

[2] This collection is similar to those mentioned by Sprague (1) which are intermediate between R. orthosporum and R. secalis in morphology. Many conidia in this collection are typical of R. secalis and many are typical of R. orthosporum. Some conidia are typical of neither species, but are two-septate, short and blocky in shape.

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WASHINGTON AGRICULTURAL EXPERIMENT STATIONS, PULLMAN, WASHINGTON, IN COOPERATION WITH THE FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE AND THE SOIL CONSERVATION SERVICE NURSERIES, UNITED STATES DEPARTMENT OF AGRICULTURE.

NOTES ON FORAGE PLANT DISEASES OBSERVED IN NORTHERN WEST VIRGINIA DURING 1953[1]

Edward S. Elliott

Rainfall during the 1953 growing season was not normal for the northern West Virginia area. An extended period of rather uniformly wet weather until June was followed by a drought period with little rainfall for the remainder of the season. The severity of a number of the diseases reported may not conform with that found during a year of normal weather conditions.

The classification of each disease is based only on observations made during 1953. It is included to give some indication of their estimated importance in this area. Each disease is classified as major (1), minor (2), rare (3), or if of unknown importance (4). The distribution of each disease is listed as general if it appeared in a number of counties. If any question existed concerning the distribution of a disease, only the county in which it was found is listed.

A few diseases are reported on grasses which have little or no forage value in this region.

ALFALFA, Medicago sativa

Ascochyta imperfecta, Black stem (1), general
Cercospora medicaginis, Black leaf spot (2), general
Corynebacterium insidiosum, Bacterial wilt (3), general
Peronospora trifoliorum, Downy mildew (4), general
Pseudopeziza medicaginis, Leaf spot (1), general
Pseudoplea briosiana, Brown leaf spot (1), Mineral and Monongalia Counties
Pyrenopeziza medicaginis, Yellow leaf blotch (2), general
Sclerotinia trifoliorum, Crown rot (1), general

ALSIKE CLOVER, Trifolium hybridum

Cercospora zebrina, Leaf spot (1), general
Colletotrichum destructivum, Anthracnose (3), Mineral County
Pseudoplea trifolii, Pepper spot (2), general
Uromyces trifolii var. hybridi, Rust (1), general

BLACK MEDICK, Medicago lupulina

Pseudopeziza medicaginis, Leaf spot (1), general
Uromyces striatus var. medicaginis, Rust (3), Preston County

BIRDSFOOT TREFOIL, Lotus corniculatus

Sclerotinia sp., Crown rot (1), Monongalia County
Stemphylium loti, (1), Monongalia County

RED CLOVER, Trifolium pratense

"Blackpatch," (2), Mineral, Grant, and Hampshire Counties
Cercospora zebrina, Leaf spot (1), general
Colletotrichum destructivum, Anthracnose (3), Mineral County
Cymadothea trifolii, Sooty blotch (2), general
Erysiphe polygoni, Powdery mildew (1), general
Fusarium spp. and other fungi, Root rot complex (1), general
Kabatiella caulivora; Northern anthracnose (1), Monongalia County
Leptosphaeria pratensis (3), Preston County
Phoma trifolii, Black stem (1), general
Pseudoplea trifolii, Pepper spot (2), general
Sclerotinia trifoliorum, Crown rot (1), general
Stemphylium botryosum, Leaf spot (2), general
Uromyces trifolii var. fallens, Rust (1), general
Virus complex (1), general

WHITE AND LADINO CLOVER, Trifolium repens

Cercospora zebrina, Leaf spot (1), general

[1] Published with the approval of the Director of the West Virginia Agricultural Experiment Station as Scientific Paper No. 486.

Colletotrichum destructivum, Anthracnose (3), Mineral County
Curvularia trifolii, Leaf spot (2), Monongalia County
Cymadothea trifolii, Sooty blotch (2), general
Pseudoplea trifolii, Pepper spot (1), general
Sclerotinia trifoliorum, Crown rot (2), general
Stagonospora meliloti, Leaf spot (4), Preston County
Uromyces nerviphilus, Rust (2), Monongalia County

BROME GRASS, Bromus inermis
Helminthosporium bromi, Leaf spot (1), general
Claviceps purpurea, Ergot (2), general

CHEAT, Bromus secalinus
Claviceps purpurea, Ergot (3), Monongalia County

FOXTAIL, Setaria geniculata
Cercospora setariae, Leaf spot (4), Mineral County

ITALIAN RYE GRASS, Lolium multiflorum
Helminthosporium siccans, Brown blight (4), Monongalia County

KENTUCKY BLUEGRASS, Poa pratensis
Colletotrichum graminicola, Anthracnose (3), general
Helminthosporium vagans, Purple spot (1), general
Ustilago striiformis, Stripe smut (2), general

ORCHARD GRASS, Dactylis glomerata
Colletotrichum graminicola, Anthracnose (1), general
Puccinia graminis, Stem rust (1), general
Scolecotrichum graminis, Leaf streak (2), general
Stagonospora maculata, Purple leaf spot (1), general
Ustilago striiformis, Stripe smut (1), general

PANIC GRASS, Panicum latifolium
Septoria tandilensis, Black spot (1), Preston County

QUACKGRASS, Agropyron repens
Claviceps purpurea, Ergot (2), general
Puccinia graminis, Stem rust (1), general

REDTOP, Agrostis alba
Colletotrichum graminicola, Anthracnose (2), general
Helminthosporium stenacrum, Leaf spot (1), Preston County

TALL FESCUE, Festuca elatior var. arundinacea
Colletotrichum graminicola, Anthracnose (3), general
Helminthosporium dictyoides, Net blotch (1), general

TALL OAT GRASS, Arrhenatherum elatius
Colletotrichum graminicola, Anthracnose (2), general
Puccinia coronata, Crown rust (1), general
Scolecotrichum graminis, Leaf streak (2) general
Septoria avenae, Speckled blotch (1), Monongalia County
Spermospora avenae, Red leather leaf (2), Monongalia County

TIMOTHY, Phleum pratense
Colletotrichum graminicola, Anthracnose (3), general
Helminthosporium sp., Leaf spot (1), general
Heterosporium phlei, Eye spot (2), general
Puccinia graminis, Stem rust (1), general
Scolecotrichum graminis, Leaf streak (3), general

Ustilago striiformis, Stripe smut (2), general

VELVET GRASS, Holcus lanatus
Colletotrichum graminicola, Anthracnose (2), general
Helminthosporium spp., Leaf spots (4), Preston County
Puccinia coronata, Crown rust (1), general

WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION

A NEW PHYSIOLOGIC RACE OF BEAN RUST (UROMYCES PHASEOLI TYPICA) FROM NEW MEXICO

W. P. Sappenfield[1]

In 1952 Fisher (1) reported the reaction of 30 races of rust, Uromyces phaseoli var. typica Arthur, on differential bean varieties. These 30 races represented the known physiologic races of bean rust.

During the same year, collections of bean rust were made in three areas of pinto bean production in New Mexico -- State College, Deming, and Estancia. One sampling was made at State College, two in the Deming area, and three in the Estancia Valley.

All samples were sent to H. H. Fisher, U. S. Department of Agriculture, Agricultural Research Service, for identification. Race identification of the New Mexico collections and their reaction on differential varieties is given in Table 1.

Table 1. Reaction of the differential bean varieties to physiologic races of bean rust collected in New Mexico, 1952.

Rust differentials	Infection grade[a] produced by collection shown					
	Deming #2	Deming #3	Estancia #1	Estancia #2	Estancia #3	State College #1
U. S. #3	3	5	5	3	3	8
643	10	10	8	0	0	10
650	10	10	10	10	10	10
765	5	8	3	0	2	8
780	10	2	2	10	10	2
814	9	2	8	9	9	2
Golden Gate Wax	0	2	0	0	0	2
Identified as race No.	30	?[b]	6	27	27	?[b]

[a] Infection grades ranges from 0 for immunity to 10 for the highest degree of susceptibility.
[b] Race not previously identified.

The collections Deming #3 and State College #1 could not be identified as one of the 30 races previously described by Fisher[2]. This fact indicates that a new physiologic race of bean rust has been found in New Mexico. It is suggested by Thomas and Fisher[3] that this new race be called No. 31.

From the five New Mexico collections four physiologic races were identified: races 30 and 31, the new race, in the Deming area, races 6 and 27 in the Estancia Valley, and race 31, the new race, in the State College area.

NEW MEXICO AGRICULTURAL EXPERIMENT STATION

[1] Assistant Agronomist, New Mexico Agricultural Experiment Station, State College, New Mexico.
[2] Fisher, H. H. 1952. New physiologic races of bean rust, Uromyces phaseoli typica. Plant Dis. Reptr. 36: 103-105.
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FUNGICIDAL CONTROL OF CLUB ROOT OF CAULIFLOWER[1]

Leo Campbell

Club root, Plasmodiophora brassicae Wor., has been known for about 100 years, during which time many experiments on the control of the disease have been conducted. The addition of lime, or lime plus calomel, to the soil, or rotation with non-cruciferous crops, accompanied by the eradication of cruciferous weeds, have been common recommendations. Since these measures have not generally proven satisfactory in western Washington, investigations with different approaches to the problems were initiated.

FIGURE 1. Row at left (stake no. 20) was untreated; center row (stake no. 13) was treated with Stauffer N-521 at the rate of 10 pounds per acre; row at right (stake no. 6) was treated with Mathieson 275 at the rate of 60 pounds per acre. Each of the above treatments extend from the stake 27 feet.

In preliminary tests in the greenhouse and in field plots, various fungicides at different concentrations and amounts were used as dips, drenches, and soil treatments for the control of club root. In 1953 the materials and methods of application found most promising in the preliminary tests were used in an experiment which ran from June 9 to September 9. Each fungicide was added as a drench and as a soil treatment in three replicates of a 27-foot row of 18 plants each. With the former method, 100 cc of each drench was added to the soil around each plant at planting time. With the latter method, each material was rototilled into the soil to a depth of 4 to 6 inches in strips about 15 inches wide one week before planting. Five- to six-week-old cauliflower plants were used as the host crop. The soil of the plot is a sandy loam, which was kept at the proper moisture content by overhead irrigation. A 10-20-20 fertilizer was added as a side dressing at the rate of about 400 pounds per acre immediately after planting. For the control of the cabbage maggot, heptachlor was used at a concentration of 2% of each drench and at the rate of 2 pounds per acre with each soil treatment and alone at the same rate in the check. The data from this plot are presented in Table 1.

Of the materials used as drenches, thiram gave the greatest reduction in club root and the highest increase in yield. Mathieson 275 (pentachloronitrobenzene) at all three rates, however, gave better control of the disease and greater increases in yield than any of the fungicides with either method of application. The data on disease rating and yields corrobroate the observed vigor of the plants throughout the plot. Those grown in soil treated with Mathieson 275 were as thrifty as would be expected if grown under the same conditions but free of the club root pathogen.

Weeds in the plot were neglected until about two weeks after the soil treatments were made. At this time a low incidence of weeds was noticed in the rows where Mathieson 275 was used at rates of 40 and 60 pounds per acre, in comparison with the rest of the plot (Fig. 1). The weeds were then cultivated out between the rows, but were not disturbed in a strip about one foot wide in each row. On August 8 the weeds from all three of the replicates of these two treatments and the untreated check were removed and weighed. These data are presented in Table 2.

[1] Scientific Paper No. 1294, Washington Agricultural Experiment Stations, Pullman.

Table 1. Disease rating, percent reduction in rating, yield of cauliflower heads, and percent increase in yield for each of 11 fungicides applied at different rates and by different methods.

Fungicide, rate, method of application		Total of three replicates			
		Disease		Yield	
Fungicide	Concentration, or rate[a]	Rating[b]	Percent decrease[c]	Number of pounds	Percent increase[c]
Untreated check	----	179	----	30.2	----
Fungicide applied as drench					
Ferbam	0.25%	181	-1.1	42.4	40.6
Thiram		121	32.4	49.9	65.2
Captan		139	22.3	41.0	35.7
Streptomycin		164	8.3	37.6	24.4
Fungicide mixed into soil					
Mathieson 275	20 lbs.	63	64.8	69.6	130.4
	40 lbs.	57	68.1	83.7	177.1
	60 lbs.	55	69.2	95.1	214.9
Stauffer N-521	10 lbs.	178	0.0	35.1	16.2
	20 lbs.	175	2.2	55.7	84.4
	30 lbs.	160	10.6	58.4	93.4
Mathieson 1194	20 lbs.	145	18.9	48.1	59.6
	40 lbs.	153	14.5	66.5	120.2
	60 lbs.	137	23.4	42.2	39.7
Mathieson 1197	10 lbs.	162	9.5	30.2	0.0
	20 lbs.	173	3.3	32.2	6.6
	30 lbs.	144	19.5	15.8	-47.6
Penn. Salt NP-1083	10 lbs.	128	28.5	42.7	41.3
	20 lbs.	124	30.7	48.2	59.6
	30 lbs.	94	47.4	32.3	6.9
Calcium cyanamide	40 lbs.	139	22.3	40.9	35.4
	80 lbs.	214	-19.0	41.6	37.7
	100 lbs.	188	-5.0	43.9	45.3
L.S.D. at 5% level		24.46		7.49	

[a] Concentration and weight based on active ingredient.
[b] Disease rating from 0, no damage, to 5, complete destruction of plant.
[c] As compared with check. Minus sign (-) represents increase in disease or reduction in yield.

An economical control of weeds by the use of Mathieson 275 at rates of 40 and 60 pounds per acre is indicated by Figure 1 and the data in Table 2. No other data on weeds were taken in the plot since no difference in their development was noticed among the other treatments.

Table 2. Weight and percent reduction in weed growth where Mathieson 275 was used at the rate of 40 and 60 pounds per acre, in comparison with the untreated check.

Treatment	Weeds from three replicates[a]	
	Weight in pounds	Percent reduction
Mathieson 275, 40 lbs. per acre	0.6	99.5
Mathieson 275, 60 lbs. per acre	1.8	98.5
Untreated check	123.0	----
L. S. D. at 5% level	19.40	----

[1] About 85 percent Amaranthus retroflexus L., 10 percent Chenopodium album L., and an occasional plant of Senecio glabellus Poir., and Lamium amplexicaule L.

Discussion

None of the treatments used for club root control completely protected the plants from infection. Those which gave a measure of control did so by reducing or retarding infection of the roots, particularly at the center of the rhizosphere. Plants given a low index rating showed only small firm clubs restricted primarily to the periphery of the root system, while on those with a high index rating almost all of the branch roots were destroyed, leaving only large central clubs, generally in an advanced state of decay.

In most of the treatments there was a positive correlation between the reduction in disease rating and increase in yield, but in some the results were inconsistent. Some treatments reduced the disease but failed to increase the yield because the material possessed both high fungicidal and high phytotoxic properties. The only chemical that gave both a substantial reduction in disease rating and large increases in yields, as compared with the untreated check, was Mathieson 275 rototilled into the soil to a depth of 4 to 6 inches in strips about 15 inches wide one week before planting, at the rates of 20, 40, and 60 pounds active ingredient per acre. Since practically all of the cauliflower heads from the rows treated with Mathieson 275 were marketable, in contrast to none marketable from the untreated rows, the percentage increase in yield of the former over the latter is much greater than is indicated in Table 1. An additional advantage of Mathieson 275 used at the two higher rates is that it will apparently control annual weeds sufficiently to make weeding within the rows unnecessary. This material, however, has not yet been approved by the Pure Food and Drug Administration. Until it is, it will not be recommended for use in western Washington for use on crops for human or livestock consumption.

These investigations will be continued in hopes of effectuating a recommendable control of club root.

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PLEOSPORA HERBARUM WALLR. AND OTHER FUNGI IN SEEDS OF SWEET ALYSSUM[1]

W. F. Crosier and C. E. Heit

Low-germinating, poor-quality samples of sweet alyssum, Lobularia maritima (L.) Desv., seed are especially common in the current crop of this flower. Packet distributors are finding that the 1953-crop seed from certain sources is much inferior to production in past years. During germination tests a low percentage of the seeds develop into normal strong seedlings, but weak, rootless, abnormal seedlings and dead fungus-contaminated seeds are preponderant in many of these new-crop stocks. The percentages of normal seedlings range from 20 to 60, with an average of approximately 35. These poor-germinating, low-quality stocks are of several varieties, including Carpet of Snow, Royal Carpet, Snow Cloth, and Violet Queen, with the last-named showing the lowest germination and most consistently poor quality from various sources. Information received from distributors has indicated that this low quality seed has been grown both in California and in the Netherlands. However, some new-crop seed grown in California during 1953 is stronger and of good quality, comparing favorably with the normal expected germination of 70 to 85 percent for the past several years.

Non-viable seeds were obscured by dark fungus hyphae. Other seeds were discolored and disfigured by small black bodies scattered irregularly over the surface. A cursory examination with a 7X lens revealed a tuberculate or verrucose surface apparently roughened by sclerotia of 0.2 to 0.5 mm. diameter.

A microscopic mount prepared from the fuliginous hyphae contained spores of both Alternaria tenuis auct. and Stemphylium botryosum Wallr. Both of these fungi and also species of Fusarium, Hormodendron, and Penicillium sporulated on dead seeds and rarely on live seeds and seedlings during germination testing. A series of tests that had been held at 18° C for 12 days yielded only 21 to 38 percent of normal and 15 to 23 percent of weak, abnormal seedlings. Neither the normal seedlings nor the seedcoats were discolored by dematiacous fungi although infrequently a few spores of A. tenuis and S. botryosum were present on the seedcoats.

Neergaard (6) found immature perithecia of Pleospora herbarum (Pers.) Rabh. surrounded by conidial patches on non-germinating seeds in the germinator. He listed 36 species from which it was obtained including several garden plants but not Lobularia maritima. Alternaria tenuis was described as a polyphagous facultative parasite occurring on 117 kinds of seeds. Several species of Alyssum were listed not including L. maritima. Baker and Davis (1) mentioned A. tenuis or S. botryosum on seeds or plants of species of Calendula, Callistephus, Gerbera, Gladiolus, and Senecio. They did not, however, observe an actual disease caused by either fungus with the possible exception of S. botryosum on Gladiolus spp.

FIGURE 1. Perithecia of Pleospora herbarum on a seed of sweet alyssum (Lobularia maritima). About 25 X.

Examination at 40X magnification showed that dead seeds in the germinator were contaminated with typical dark neutral gray to black perithecia of Pleospora herbarum. Perithecia were borne superficially without evident stromata, singly or scattered over the entire seed surface to gregarious or occasionally 12 to 20 crowded together on a single seed. Diameter varied from 250 to 510 microns, with an average of 381 microns.

The usual test period for alyssum seed is six to eight days, during which time normal ger-

[1] Journal Paper No. 961 of the New York State Agricultural Experiment Station, Geneva, New York.

Table 1. Characteristics of airblast separations of commercial lots of sweet alyssum seed.

Type of separation	Size of seeds	Weight of 100 seeds	Seeds appearing to be			Perithecia present
			Filled	Discolored	Chaffy	
	Microns	Grams	Percent	Percent	Percent	Percent
Lot A, Royal Carpet Variety						
Bulk	937 x 1322	22	53	36	11	0.3
Light	918 x 1355	12	10	51	39	0.5
Medium	927 x 1319	19	68	26	6	1.0
Heavy	972 x 1302	27	77	21	2	0.0
Lot B, Violet Queen Variety						
Bulk	983 x 1301	23	51	33	16	0.03
Light	929 x 1160	15	24	40	36	0.1
Medium	1022 x 1287	24	56	34	10	0.0
Heavy	1026 x 1354	27	71	28	1	0.0

Table 2. Performance of airblast separations, and of Arasan-treated portions, of sweet alyssum seed.

Type of separation or portion	Seeds on blotting paper				Sterilized seeds on agar			
	Normal germination	Fungi present			Total germination			
		Pleospora herbarum	Alternaria tenuis	Fusarium[a]		Infected seedlings	Stemphylium botryosum[b]	Alternaria tenuis
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Lot A, Royal Carpet Variety								
Bulk	33	21	5	1	-	-	-	-
Treated	36	6	tr	0	-	-	-	-
Light	2	17	8	0	5	3	81	22
Medium	24	19	9	tr	55	29	34	3
Heavy	65	10	2	0	67	9	11	1
Lot B, Violet Queen Variety								
Bulk	18	10	6	tr	-	-	-	-
Treated	17	4	2	0	-	-	-	-
Light	12	24	14	1	15	9	40	6
Medium	23	21	14	tr	21	0	24	15
Heavy	30	23	9	tr	32	2	15	9

[a] Apparently at least two undetermined species.

[b] In part represented by perithecia (Pleospora herbarum).

mination is completed. These weak low-germinating stocks of the 1953 crop were often left on the blotters for a longer period because of the slow and weak response.

During a 12-day germination period, perithecia developed on one-fourth to one-half of the dead seeds. Conidia of Stemphylium botryosum were not always present. At least 5 percent of the seeds were infested with Alternaria tenuis alone; another 5 percent were contaminated both with perithecia of Pleospora herbarum and with A. tenuis. Species of Fusarium, Hormodendron, and Penicillium were present on less than 1 percent of the dead seeds, occurring either alone, together, or with P. herbarum.

When 3500 dry seeds of the 1953 crop were examined, perithecia were observed on only 7. Several of the apparently filled seeds and all of the chaffy, shriveled ones were discolored internally, which is indicative of dead embryos and/or fungus hyphae. The discolored and chaffy seeds were not viable.

In an attempt to improve the germination, each lot of seeds was divided by air flotation into three portions. As indicated in Table 1, the visual appearance, weight, and viability of the heavy separation was markedly better than in the original sample.

The seeds with discolored interiors were not entirely removed by air, hence it was expected that fungi would develop in the heavy as well as in the lighter separations during germination. The results from two lots, as given in Table 1, show that some fungi were retained in all separations but that they were more abundant in the light-weight seeds.

When plated on agar, the heavy separation yielded fewer fungus colonies than did the lighter ones. Pure cultures of Pleospora herbarum predominated, but as shown in Table 2 Alternaria tenuis also was carried internally. Nearly one-half of the seeds infested with A. tenuis yielded P. herbarum as well. An average of 71 percent of the growths of the latter fungus were represented by perithecia and 29 percent by conidia only.

With a few exceptions no live seeds carried Pleospora herbarum or other fungi. Hyphae extending from the infested dead seeds, however, killed seedlings in the agar plates. The descending order of pathogenicity was: P. herbarum, Alternaria tenuis, and Hormodendron sp. Seedlings on blotters or in sterilized soil were rarely infected. The same conditions that favor infection of flowers and decadent foliage (3, 4, 5), especially high humidity, would probably be favorable for infection, however.

Arasan dust always reduced the activity of the fungi. Germination tests were noticeably cleaner but this in no way influenced the performance of the live seeds and the development of the seedlings. Apparently the injury caused by these fungi occurs in the field or during the curing-drying process and, in contrast to Botrytis cinerea Fr. on China aster seed (2), for example, it is not a problem in the seed laboratory.

When the 1953 crop of Lobularia maritima is compared with those of previous years it is surmised that the growing areas, cultural practices, or climatic conditions have changed. One grower in California harvested high quality seed in 1953 but neither his growing nor processing methods are known. It is possible that he was able to plant at the usual time and hence enjoyed a longer growing season than other seedsmen who were retarded by adverse spring weather. As suggested by Baker and Davis (1), disease-free seed may also be obtained from harvesting and threshing the plants in such a manner as to discourage semi-parasitic development of these facultative saprophytes. They also observed that flower seed from certain areas in California is commonly infected by Alternaria and Stemphylium spp., whereas in the dry interior valleys the environment is conducive to production of clean seed.

According to Justham and Ogilvie (5) Pleospora herbarum causes a premature defoliation of beans in England. The seed from infected fields may be reduced both in quality and quantity. If plants of Lobularia maritima are similarly infected, the seeds are probably unable to mature properly; or, as reported by Jones (4), direct infection of the flowers may take place, to the detriment of seed formation.

In conclusion, it is believed that neither Alternaria tenuis or Stemphylium botryosum killed the flowers or seeds of Lobularia maritima directly. It is more likely that climatic or cultural conditions favoring development of the fungi on decadent tissues were unfavorable to seed formation, or that adverse conditions were prevalent during the curing, drying, and harvesting period.

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RELATION OF TYPE AND AGE OF WOUND TO INFECTION BY ENDOCONIDIOPHORA FAGACEARUM BRETZ

Bert M. Zuckerman

The relation of type of wound and infection and age of wound and infection by the oak wilt fungus was studied under greenhouse conditions. Wounds made on two-year-old red oak (Quercus rubra L.) and live oak (Q. virginiana Mill.) seedlings in the greenhouse were of the following six types: 1) buds removed; 2) holes pierced in buds with a dissecting needle; 3) leaves broken off at point of attachment of petiole to stem; 4) leaves torn in half at right angles to the midvein; 5) stems broken; and 6) bark torn so that the wood was exposed. These diverse types of wounds were made to simulate injuries to trees produced in nature by agents such as insects, wind, hail, and lightning. The first two types of wounds were made only on red oaks. The other four types of wounds were made on both red and live oaks, one tree in each of the first 7 series of time and wound classes being a red oak, the other two live oaks, and all three trees in the last 3 series of time and wound classes being live oaks. Only one wound was made on each tree.

At the inception of the experiment the greenhouse temperature was 24° C and the relative humidity 85 percent. All of the wounding was done under these conditions and all of the tree lots sprayed with spores immediately after wounding were sprayed under these conditions. Also, all later sprayings were done under very closely similar conditions. During the course of the experiment greenhouse temperatures remained at approximately 24° C during the day and approximately 20° at night. The relative humidity varied greatly, ranging from 20 percent immediately prior to daily watering to 100 percent after watering.

Cultures originating from a single spore isolate of Endoconidiophora fagacearum were used as sources of inoculum in this experiment in order to eliminate variability due to differences in strains of the fungus. Conidial suspensions were prepared from seven-day-old cultures of E. fagacearum which had been grown on potato-dextrose agar. The suspensions were adjusted to concentrations of approximately 1.25 million spores per ml. of distilled water. Conidial suspensions were atomized onto wounded surfaces with a Rexal No. 1543 hand atomizer, the nozzle of which was pointed directly at the wound and held at a distance of 2 to 3 inches from the wound. Atomizing was done immediately after wounding or at one of the nine time intervals, which extended from 1/2 hour to 120 hours after wounding, given in Table 1. Each time and wound class had 3 replicates; hence, 3 was the maximum number of infections that could occur in any class. Thirty trees, inoculated in groups of 3 corresponding to the 10 time classes but not wounded, served as controls. In all, 210 trees were treated.

The number of infections that occurred through each type of wound at each time interval are recorded in Table 1.

Of the trees inoculated after the bark was torn, 100 percent became affected with wilt when wounds were less than 48 hours old. These results are good enough to suggest this method of inoculation for greenhouse studies in which it is necessary to infect large numbers of trees.

Of the 30 trees inoculated after their stems were broken 21 became infected. Three trees became infected when inoculated 48 hours after wounding, two trees became infected when inoculated 72 hours after wounding, and one tree became infected among those inoculated at 96 hours and at 120 hours after wounding. These results show that infection can occur through wounds older than 24 hours, although it is indicated that the possibility of such infection decreases as the age of the wound increases.

Inoculation of trees from which leaves were removed gave the smallest number of infections (considering only wound types which permitted infection). The longest time interval between the breaking off of a leaf and successful inoculation was six hours.

Torn leaf blades were susceptible to infection for at least 24 hours after wounding. Infection through torn leaves has not been previously shown, to the best of the author's knowledge, although infection by injection of conidial suspensions into the leaf midvein has been reported. These results suggest that under some conditions leaf-feeding insects may serve as vectors of oak wilt.

No infection occurred through injured buds or fresh bud scars. The failure of infection to occur through buds and bud scars is of interest, since several of the insects associated with wilt-killed trees are known to feed on buds. However, since this experiment was conducted in the late summer and fall, the possibility that buds may serve as infection courts in the spring when they are active should be investigated.

Most of the infections occurred in trees that were inoculated up to 24 hours after wounding.

Table 1. Number of trees infected with the oak wilt fungus in relation to type of injury and time of spraying with inoculum.

Time interval between wounding and inoculating (hrs.)	Type of wound						
	Not wounded	Bud removal[a]	Hole pierced in bud[a]	Leaf broken off[b]	Leaf torn[b]	Bar broken[b]	Bark torn[b]
Immediate	0	0	0	3	3	3	3
1/2	0	0	0	2	2	2	3
1	0	0	0	2	2	2	3
2	0	0	0	0	2	2	3
6	0	0	0	1	0	2	3
24	0	0	0	0	1	3	3
48	0	0	0	0	0	3	0
72	0	0	0	0	0	2	0
96	0	0	0	0	0	1	0
120	0	0	0	0	0	1	0
Total trees infected	0	0	0	8	10	21	18
Total trees tested	30	30	30	30	30	30	30

[a]All red oaks.

[b]One red oak and two live oaks were treated in each time and wound class except the 72-, 96- and 120-hour classes, in which only live oaks were treated.

Fifty of the 57 trees that showed symptoms were in this category. Only in the instance of stem breakage, this being the most severe type of wounding attempted, did infection occur in plants inoculated when the injury was 48 hours old or older.

Initial wilt symptoms occurred from 25 to 98 days after inoculation. Infection was confirmed by isolation of the fungus from wilting trees. None of the trees that were not wounded and that were sprayed with spore suspensions wilted.

The contrast between these tests and natural conditions should be recognized. The insect vector of oak wilt must in some way make contact with sporulating growth of E. fagacearum, according to current theories of transmission (1, 2). Be this contact short or long, the amount of inoculum one or several insects could carry to a wound on a healthy tree is minute compared with the spore load with which the trees were treated in this experiment. The amount of moisture introduced into the wound by atomizing could easily be exceeded in nature during rainy periods. However, there is probably a point where no infection occurs through injured leaves or stems no matter how high the moisture or how great the quantity of inoculum. The rapidity with which the wound closes probably is characteristic of each type of tissue. In this experiment the succulent leaf tissues appeared to render themselves immune from infection more quickly than the woody tissues.

Summary. The probability that a wound on an oak tree can serve as an infection locus for oak wilt decreases as the time between the making of the wound and the arrival of the inoculum increases. The data reported in this paper indicate that wounds not over 24 hours old provide more favorable ingress for the fungus than wounds which are older. Infection was obtained more easily through wounded stem surfaces than wounded leaves. Among the trees with broken stems only one of the three inoculated 120 hours after injury became infected. Since 120 hours was the longest interval between wounding and inoculation in this experiment, it is possible that inoculation of older wounds of this kind might result in infection. No infection was obtained through wounded buds, through wounds left by broken-off buds, or in uninjured trees.

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IDENTIFICATION OF OAK WILT ISOLATES AS RELATED TO KIND OF INOCULUM AND PATTERN OF DISEASE SPREAD

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Bretz (4) found that fertile perithecia were formed when certain isolates of Endoconidiophora fagacearum Bretz were grown together in culture. Since single isolates did not produce perithecia, he suggested that the fungus was heterothallic. Hepting et al. (6) confirmed this observation and designated the two thalli or strains as A and B. Most single-tree infections have been found to be of single strain origin. Rarely have both A and B thalli been found in the same infected tree (1, 2, 5, 6, 7).

A knowledge of the strain characters of oak wilt isolates in statewide and in local area oak wilt infections might be an aid toward discovering the pattern and kind of inoculum important in the overland spread of the disease. In this study the strain identities of 79 isolates from individual trees from the 1951-52 Pennsylvania Oak Wilt survey were determined. These isolates were from 54 separate local oak wilt areas. The term "area" refers to a group of trees affected by oak wilt. The trees in this group may or may not be within root-grafting distances of each other. If a single infected tree is found a great distance from any known group, it constitutes an area also.

PROCEDURE AND RESULTS

The procedure followed in establishing that oak wilt is present in a suspected area is to culture chips from the outer sapwood from a tree showing typical symptoms. Not all of the affected trees within root grafting distance (50 feet) are sampled. If, however, surrounding trees beyond the arbitrary 50-foot distance show symptoms, they too are often laboratory checked. The isolates used in this study were obtained in this way.

The 79 isolates were first grown alone on PDA (10) (made with unpeeled potatoes) to determine whether they were capable of producing perithecia without crossing with a compatible strain. PDA was found as effective as chestnut agar in preliminary tests with crossing known compatible strains. All cultures in these tests were grown at 20° C. Three isolates produced fertile perithecia with well-formed ascospores. This would indicate that the three trees from which the isolates were obtained were infected with both A and B strains (6, 7) and might have produced perithecia in nature without spermatization from a different source (9).

Two plates each of the 76 remaining isolates were then grown alone on PDA for ten days. One plate of each isolate was then atomized with a suspension of conidia and mycelium, of a known (5) A type strain of E. fagacearum. The suspensions were prepared by scraping cultures growing on PDA into distilled water and mixing in a blendor. The other plate of each isolate was atomized with a known B strain. Eight replicates of this procedure were made.

It was found that some of the isolates would not react with the single strain of A or B used. Several isolates of known A types were mixed and this was used as the A spermatizing medium. A similar mixture of B types was used. All such isolates thus gave positive reaction with fertile perithecia production.

Thirty-two isolates crossed with A strain, indicating they were of B type.

Thirty-five isolates reacted as A type.

Isolates from nine trees reacted with either A or B strains indicating they were probably heterothallic in character (7), composed themselves of A and B thalli. Being of this nature it would appear that each should produce ascospores when grown alone in culture, but as with some of the single strains tested, perithecia were not produced when only one isolate of the opposite type was introduced. When a mixture of isolates of the opposite type were used, fertile perithecia grew. Satisfactory compatibility for perithecia development did not appear to be present in the A and B thalli within the isolate.

To summarize the kinds of isolates of Endoconidiophora fagacearum found in these 79 trees: 35 trees of A compatibility; 32 of B type; and 12 of a heterothallic nature, probably containing a mixture of A and B.

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OBSERVATIONS

A and B strains present in the same area. Table 1 indicates that both A and B strains were present within a single area in 16 of the 54 areas represented. For 35 areas only one isolate was identified and these were single strains. Three areas where multiple isolates were identified were also single strains.

The isolates identified provide only 19 areas where it is possible to check on the presence of A and B in the same area. In 16 of the 19 areas A and B strains were present.

Counties. Seventeen counties are represented by the 79 isolates identified. In every county where more than one isolate was identified, both A and B strains were present within the boundaries of those counties.

Nine counties had only one isolate identified and these were of a single strain character, so it is not possible to say whether the opposite strain was also present. See Table 1.

Single Trees. Twenty-seven isolates were from new one-tree infections, separated from other diseased trees by 50 to 500 feet. Thirteen of these infections were of A type; nine were B strains; and five were of mixed A and B types. See Table 1.

Table 1. Distribution of compatibility types of the oak-wilt fungus by counties in Pennsylvania

County	Strains isolated					
	Total Areas			*New Single Tree Infections		
	A	B	A & B	A	B	AB
Adams	1	---	1	---	---	1
Allegheny	1	4	---	1	---	---
Armstrong	---	1	---	---	---	---
Bedford	5	1	11	8	6	4
Blair	---	1	---	---	---	---
Clarion	1	---	---	1	---	---
Cumberland	1	1	1	---	---	---
Erie	1	---	---	---	---	---
Franklin	1	2	2	---	1	---
Greene	1	---	---	1	---	---
Huntingdon	1	1	1	1	1	---
Indiana	1	---	---	---	---	---
Jefferson	1	---	---	---	---	---
Juniata	1	---	---	---	---	---
Mifflin	1	1	---	---	---	---
Perry	3	5	---	---	1	---
Westmoreland	1	---	---	1	---	---
Total	21	17	16	13	9	5

*These trees included in the Total Area column

DISCUSSION

The theory (8) that the spread of the oak wilt disease within a local area is due to the transmission of the fungus through established root grafts between like oak species is generally accepted.

The manner of overland spread is still unsolved.

The research thus far on identification of single tree infections has shown a great majority of single strain isolates, with only an occasional isolate having both strains present in it. This presents some questions: Does the overland spread of oak wilt within a geographical section beyond root-grafting distances appear to be from a center of like strain infections by means of asexual spores? If such were the case all new infections around an original site would expectedly be of the same strain as the original.

If ascospores were the principal inoculum would there not be more infections where both strains are present in the same isolate? The nature of the insoluble mucoid mass in which the

mixture of A and B ascospores are borne make the likelihood of one strain inoculation seem improbable.

The results of this research are not comprehensive enough to be conclusive, but they do present some evidence towards answering the questions.

The results here suggest that both strains A and B are present in nearly every oak wilt area. This is in agreement with the findings of Barnett (2). Indications are that both strains are probably present in every county-size area, and even in most local areas. New infections (Table 1) around an old infection site are not of one type, but may be either A or B, or even single trees with mixed A and B. This does not dismiss the theory of spread by asexual spores since both A and B conidia are present in many such areas. It does, however, provide the fungus elements for diploidization (9) leading to the production of ascospores.

Both ascospores (4) and conidia have been used successfully in artificial inoculation of trees.

Ascospores would appear to be better inoculum for overland spread than conidia. Because a large number are bound up in a sticky mucoid mass, it is probable that a vector would be able to pick up and carry more ascospores than conidia under the same conditions. More inoculum in the tree wound would likely increase the chance of infection. Resistance to loss in viability would favor ascospores also because of their mass mucoid state.

Since ascospores would appear to be the more efficient inoculum and since the A and B strains necessary for their production appear to be present in most oak wilt areas, it would seem there should be more single-tree infections showing a mixture of A and B strains. Boyce (3) found that 22 of 23 naturally infected trees in the Southern Appalachians were of single-strain infection. Barnett (2) found that 41 out of 43 infected trees in a West Virginia study were single-strain types. The present study in Pennsylvania revealed 67 single strain isolates and 12 of mixed strains.

Artificial inoculations with mixed strains of A and B conidia and ascospores have not yielded mixed-strain infections. Barnett (2) found that of six trees so inoculated only single strains were reisolated from each of five trees, with only one tree yielding a mixed A and B isolate.

This suggests that under natural conditions inoculations with ascospores frequently result in single-strain infections, and that conidia may not be as important as would appear from the preponderance of single strains present.

The ratio of type A and B infections found in nature is approximately half and half. In the present study 32 B types and 35 A were found. The ratio of A and B ascospores exuding from the perithecium should be about half and half, as that is the way they are formed in the ascus. In causing infection therefore, it would be expected there would be close to half of B strains and half of A.

Such a ratio would not be expected of infections caused by conidia. One strain, A or B, would expectedly be in the majority in a particular area, dependent on which conidial strain caused the original infection.

SUMMARY

Seventy-nine isolates of Endoconidiophora fagacearum from 54 Pennsylvania oak-wilt areas were identified as to compatibility type. Thirty-five isolates were of A type; 32 were B; and 12 were mixed A and B.

In 16 of 19 infection areas afforded by this material, both A and B strains were present within the same area (35 areas had only one single-strain isolate identified, 3 multiple isolate areas were single-strain). Both A and B strains were present in every county where more than one isolate was identified.

The presence of A and B strains in most oak-wilt areas provides the fungus elements for the production of ascospores in such areas. Ascospores may be an important kind of inoculum.

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CORTICIUM GALACTINUM DOES NOT CAUSE WHITE PINE NEEDLE BLIGHT[1, 2]

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White pine needle blight, a disease of unknown origin, is characterized by discoloration, dieback, and dwarfing of current season needles of Pinus strobus. For 50 years the disease has been the object of much speculation regarding its possible causes. Because of the systemic nature of the foliage symptoms, it has been believed generally that they are preceded by distrubance of the root system, and deficiency of soil moisture has been regarded by many observers as a direct or indirect factor in causing the needle disorder.

The reported association (7) in 1948 of a virulent, root-rotting fungus, Corticium galactinum (2), with blighted trees suggested the possible pathogenicity of this fungus on feeding roots of white pine as a cause of this needle blight. The fungus was observed to be growing profusely in the needle litter beneath diseased trees with which it formed a thick white to buff-colored mycelial mat (Fig. 1, A), and appeared to be in intimate association with small, absorbing rootlets of the trees. An investigation was undertaken to determine the relationship of this fungus to white pine needle blight.

METHODS

Attempts were made to isolate the fungus from roots of trees with which it had been associated. A series of pathogenicity tests were made on roots of potted pines. Surveys were made of fungi associated with roots of adjacent blighted and healthy trees, and of mycelial mats in needle litter beneath these trees.

Isolation Trials: Over a two-year period persistent trials were made to isolate the fungus from living and dead roots of trees with which it had been reported associated. A total of 360 individual root sections from ten trees were collected and treated for isolation of the fungus. These sections were about 1 inch long and varied from 1/16 to 1/4 inch in diameter. The larger ones were treated intact or with bark removed, but the smaller ones were treated only with bark intact. Root sections were surface sterilized in a 1/1000 solution of mercuric chloride for 90 seconds, washed twice in sterile, distilled water, and placed on malt extract agar with a pH of 4.7. Mycelia emerging from root sections (Fig. 1, B) were hyphal-tipped for pure culture.

Pathogenicity Tests: The attempt to induce symptoms of needle blight was made by inoculation of roots of potted white pine seedlings with pure cultures of C. galactinum. Seedlings of four and six years of age, potted in coarse or loamy sand, were used as test specimens. Inocula consisted of nine different isolates of C. galactinum obtained from the following hosts and geographic sources: 1 from apple (Malus pumila), Virginia; 1 from Alpine fir (Abies lasiocarpa), British Columbia; 1 from balsam fir (A. balsamea), Ontario; 1 from red spruce (Picea rubra), Maine; 1 from white spruce (P. glauca), Ontario; 1 from black spruce (P. mariana), Ontario;

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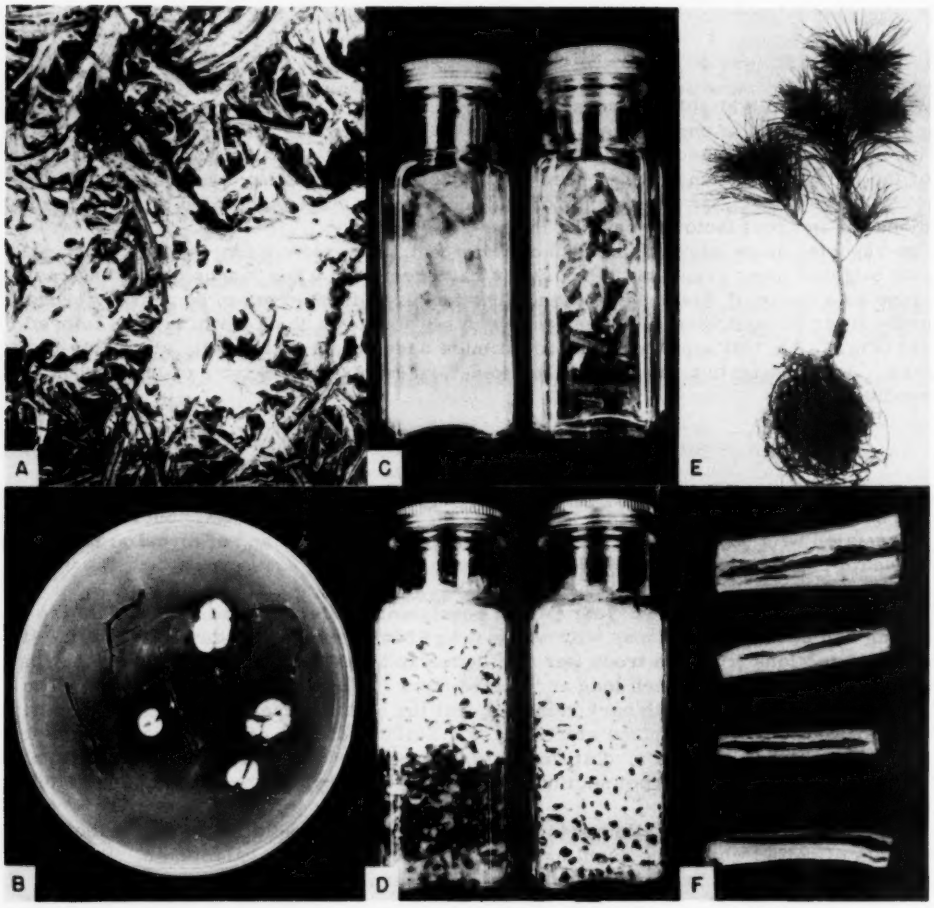

FIGURE 1. A, Mycelial mat of Corticium galactinum in needle litter of white pine. B, petri plate of malt extract agar with fungal mycelia emerging from surface sterilized root sections. C-D, culture of C. galactinum on apple twigs and wheat seed. E, seedling of white pine with inoculation twig attached. F, clean callusing of inoculation wounds without infection.

2 from white pine (Pinus strobus), Ontario; 1 from red pine (P. resinosa), Wisconsin. The inocula were prepared and applied to the seedlings in two different ways. The fungus was cultured on apple twig sections (Fig. 1, C) one inch in length and 1/8 to 1/4 inch in diameter, for a period of six weeks, and twigs so inoculated were bound to wounded roots an inch below the root collar. The fungus was also cultured on sterilized, whole-grain wheat seed (Fig. 1, D.) for a similar period, and the inoculated seed was mixed in the soil to be applied to the seedlings. The seedlings were potted in 4- or 6-inch pots during October 1950, and were allowed to harden off in an unheated greenhouse over winter. A month prior to inoculation of seedlings with apple twigs and inoculated grain, the inoculated grain was mixed with the soil at a rate of 15 percent by volume.

Seedlings were inoculated during the last two weeks of March 1951, by binding the inoculated twigs to roots with parafilm (Fig. 1, E), and by introducing inoculated soil to roots. Half the specimens were transplanted directly into inoculated soil; to the other half inoculated soil was

applied to a depth of 2 inches in the pots, the soil previously occupying this space having been discarded. The experiment was carried out in four randomized blocks, each block containing eight different combinations involving two age classes, two soil types, and two treatments at inoculation. Of the 12 seedlings in each combination 9 were inoculated with various isolates of the fungus and the remaining 3 were controls. At time of inoculation and at two-week intervals the 384 specimens were measured for terminal stem growth, needle length, needle dieback, and needle color. The following indices were assigned for needle discoloration[4]: normal green = 0; yellow green = 1; yellow = 2. Data were recorded until elongation of needles was complete.

Symptom condition indices were calculated for each seedling through a formula[5] based on indices for needle color and measurements of needle length

(Symptom condition index = Needle length - 60 x Needle color index - 10).

Calculated indices were coded and an analysis of variance was made (Table 3) for the effects of inoculation, age of seedlings, soil types, and treatment during inoculation.

Nine months after inoculation all the specimens in one of the blocks were removed from the pots, and their roots were examined for evidence of infection. Each root system was first washed in tap water. From positions above, below, and at the inoculation site, root sections 1 inch long were selected for reisolation tests. Six additional root sections 1 to 3 millimeters in diameter and 1 inch long were selected at random. Bark was removed from all of the thicker sections; that of the thinner sections was left intact. All root sections were surface sterilized and placed on agar as mentioned above. Mycelia growing from root sections were isolated in pure culture for comparison with stock cultures of C. galactinum. An examination for mortality was made of 20 root ends of the smallest and finest long roots (5) selected at random from each seedling.

Survey of Root Fungi: A survey of fungi associated with roots of adjacent diseased and healthy trees was made in the fall of 1951. Root samples from 80 pairs of such trees were taken from the upper 4 inches of soil within 4 to 6 feet of the base of each tree, and were selected for abundance of small absorbing rootlets. Distance between paired trees varied from 4 to 30 feet. Isolation of fungi was made in the manner described above. From each tree 12 root sections were taken; isolated fungi were typed and tabulated for each tree. An examination was made of the needle litter beneath the same paired, diseased and healthy trees from which root fungi were isolated, for presence of the white to buff-colored mycelial mats mentioned above.

RESULTS

All the results obtained indicate that C. galactinum does not infect roots of white pine and cause needle blight.

Isolation Trials: All efforts to isolate C. galactinum from the blighted pines with which it had been reported associated were unsuccessful. The fungus was never obtained in pure culture from either living or dead root sections from these trees. Of the various fungi isolated from root sections, none resembled known cultures of C. galactinum when examined microscopically. Negative results from the 360 isolation trials indicated that the fungus had not infected the fine rootlets of the diseased trees. Mycelia in the soil immediately surrounding feeding roots of the diseased trees did not appear to be different from those of common mycorrhizal fungi on healthy trees, and no evidence of rootlet mortality associated with mycelial mats was observed. When examined microscopically, mycelial strands attached to small roots appeared dissimilar in hyphal features to C. galactinum.

Pathogenicity Tests: Symptoms of needle discoloration and dieback were apparent on both inoculated seedlings and controls before needle growth was complete. On some seedlings a yellow mottling over part or all of individual needles occurred. Intensification of mottling did not appear to impair needle growth, and was more common on the distal third of affected needles. Efforts to isolate fungi from needles so discolored were unsuccessful. Some needles turned completely yellow and fell prematurely, but substantial fall of current needles did not occur.

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[4] All color determinations were according to Ridgway (9).

[5] Suggested and derived by Prof. M. H. Quenoille of the Mathematics Department of Yale University.

Table 1. Summary of mean data from inoculated seedlings and controls.

Measurements	Inoculated seedlings	Control seedlings	Standard errors of the difference
Stem length (mm.)	75.5	72.9	±3.32
Needle length (mm.)	47.8	42.8	±1.38
Color Index	0.39	0.79	±0.057
Needle dieback (mm.)	0.53	0.51	±0.076
Calculated Indices	14.4	-14.6	±3.89

Table 2. Mean symptom condition indices[a] of inoculated seedlings and controls.

Seedling treatment	Established at inoculation				Transplanted at inoculation				Mean
	Coarse sand		Loamy sand		Coarse sand		Loamy sand		
	Age 4	Age 6	Age 4	Age 6	Age 4	Age 6	Age 4	Age 6	
Inoculated seedlings	6.48	4.58	5.83	6.11	7.26	6.22	7.89	7.33	6.41
Controls	2.83	2.92	4.50	4.25	3.43	3.08	3.81	3.58	3.65

[a] Calculated by symptom index formula and coded as follows: divided by 10, rounded off to nearest whole number and five points added.

Table 3. Analysis of variance of inoculated seedlings and controls.

Source	Degrees of freedom	Sum squares	Mean squares
Total	383	4498.50	
Treatments (Tr.)	95	1506.25	
Blocks (B)	3	17.32	5.77
Tr. x B.	285	2965.93	10.41
Effects			
Age (A)	1	28.71	28.71
Soil (S)	1	59.33	59.33*
Treatment (T) at inoculation	1	89.13	89.13**
AS	1	34.49	34.49
AT	1	0.00	0.00
ST	1	0.17	0.17
AST	1	4.76	4.76
Inoculated vs. Controls	1	559.72	559.72**

* = Significant at .05 level of probability.
** = Significant at .01 level of probability.

Table 4. Rootlet mortality of inoculated seedlings and controls.

	Total seedlings examined	Total rootlets examined	Percentage rootlets dead
Inoculated seedlings	72	1440	2.01
Controls	24	480	2.50
Totals	96	1920	

In most cases second-year needles of seedlings so affected were shed prematurely, sometimes prior to complete emergence of current needles. Needle color of such seedlings did not improve throughout the growing season, and the needles invariably were rated yellow-green or yellow in the final recording.

Yellowing of needle tips, occasionally followed by dieback, also occurred. On discolored needles the transition from yellow to normal green was gradual and yellowing sometimes progressed but a few millimeters during the summer. Where yellowing increased to 5 millimeters or more, actual dieback of 1 or more millimeters often occurred. This type of discoloration and dieback was characteristic of normal second-year needles prior to shedding. There was a highly significant difference in the percentage of second-year needles living and present between seedlings with current normal green and yellow-green needles.

There were no significant differences in symptom condition indices between blocks (Table 3). Data from inoculated seedlings and controls were averaged and are summarized in Table 1. There were no significant differences between inoculated seedlings and controls for stem length or needle dieback, but the needle length of the inoculated group was significantly higher than that of the controls and significantly lower in color classification. Since higher values for needle length and lower indices for color represented healthier seedlings, both of the differences indicated the same trend. Either one of these measurements indicated the disease classification to which the seedlings belonged, but the combined index (needle length - 60 x needle color index - 10) distinguished more accurately between inoculated seedlings and controls. Positive values of the index indicate the inoculated group; negative values indicate controls. Table 1 illustrates these results.

From Table 2 it is evident that a greater incidence of needle blight symptoms occurred on the control seedlings than on those inoculated, since higher indices indicate healthier seedlings. The difference (3.65-6.41) was highly significant (Table 2). This result is contradictory to the hypothesis that the fungus may be responsible for white pine needle blight and suggests that it may be a mycorrhizal fungus. Under the conditions of this test C. galactinum was not pathogenic on white pine. There was a significant difference between the effects of coarse sand and loamy sand, a greater incidence of needle blight symptoms occurring on seedlings in coarse sand. There was a highly significant difference between treatment effects at inoculation, the established seedlings being more adversely affected. There was no significant difference in symptom expression between seedlings of 4 and 6 years of age.

The attempts to isolate C. galactinum from roots of inoculated seedlings were unsuccessful. Several of the same fungi obtained in the survey of root fungi were isolated, but none were similar to C. galactinum. The results of these trials indicated that the roots of inoculated seedlings were not infected with the fungus in spite of its abundance in the pots. Examination of inoculated roots and those of controls included an estimate of rootlet mortality, observations on fungus growth and healing of inoculation wounds. Data on rootlet mortality are presented in Table 4. Considering the nine to three ratio of inoculated seedlings to controls, there was no significant difference in mortality of rootlets between the two groups.

When seedlings were removed from the pots the fungus was growing profusely from several inoculation twigs and all twigs were thoroughly rotted. In some cases the fungus had formed a dense mycelial coating extending downward from 1 to 2 inches and encircling the main root. This mycelium did not extend to any of the fine roots. When the mycelium and bark were removed for examination of the wound site and for isolation trials, there was no evidence that the mycelium had penetrated the xylem. In every case the wounds showed clean callus formation (Fig. 1, F); and in some cases they were healed over completely. No signs of cankers or hypertrophy of any type were evident. It is significant that the fungus did not invade exposed root tissue in spite of its mass development in that area, and that it did not extend to the distal roots.

Survey of Root Fungi: A wide variety of fungi was isolated from roots of both diseased and healthy trees. Thirty-nine fungi were recognized as distinct, based primarily on macroscopic culture features such as pigmentation, zonation, sporulation, and growth rate. Microscopic examination was made of all fungi macroscopically similar to C. galactinum and they were compared with stock cultures of this fungus. Two fungi were obtained from two diseased trees that were not obtained from healthy ones. Each fungus was obtained but once and from two different trees. Neither of these was in any way similar to C. galactinum. It is significant that C. galactinum was not isolated from either healthy or diseased trees, and that no fungi were consistently isolated from diseased trees. Since some fungi which grow more slowly than C. galactinum on the media used were isolated, it is improbable that this fungus would not be isolated if present.

The presence of mycelial mats similar in both color and structure to those previously mentioned was not significantly different in occurrence under healthy trees than under diseased ones. In 85 percent of the 80 paired comparisons there was no difference at all. In 9 percent of the cases the mycelial mat was present under diseased trees and absent under healthy ones; in 6 percent the reverse was true. The slight differences were not significant.

DISCUSSION

No evidence was obtained to support the view that Corticium galactinum is responsible for needle blight of white pine. Failure to isolate the fungus from roots of trees with which it was reported associated is evidence that it had not infected small feeding roots of the trees, although present beneath them in the needle litter. The physical attachment of profusely growing mycelia to roots of white pine in itself is not evidence of pathogenicity and may be regarded as normal development of mycorrhizal fungi (3, 4, 8). The greater incidence of needle blight symptoms on the uninoculated seedlings and the failure to isolate C. galactinum from roots of those inoculated demonstrate that the fungus was not responsible for the occurrence of needle blight symptoms in this test. Although introduced to white pine seedlings under conditions favorable to its development the fungus was apparently unable to infect the seedlings. The failure to isolate C. galactinum in the survey of fungi from roots of 80 diseased white pines provided additional weight to the evidence for non pathogenicity. It does not seem probable that a fungus could be responsible for needle blight symptoms by infection and destruction of large numbers of feeding rootlets of 80 trees without being isolated at least a few times.

Since this study was initiated it has been demonstrated that C. galactinum is a common wood-decaying organism of mature white pines and other conifers (1, 6, 10, 11). As a root and butt rot of white pine it has not been more prevalent in or confined to trees with needle blight although needle blight was present in the stands examined (6). If, in addition to being present as a root and butt rot, it were able to infect and destroy small feeding rootlets, it would be expected to infect them in every case where root and butt rot occurs. The presence of C. galactinum as a common root-rot fungus of white pine without evidence of its association in trees affected with needle blight symptoms is additional evidence of the inability of the fungus to parasitize and destroy the fine roots of white pine and cause needle blight symptoms.

From the results obtained in this study concerning the association of C. galactinum with needle blight symptoms, and from the record of this fungus as a root and butt rot in trees without symptoms of needle blight, it is concluded that there is not sufficient evidence to warrant consideration of this fungus as a cause of white pine needle blight.

SUMMARY

The reported association of Corticium galactinum with white pine needle blight had led to speculation that this fungus may be primarily responsible for the disease by destroying feeding rootlets. To test the virulence of the fungus as a pathogen on roots of white pine, the roots of 288 4- and 6-year-old seedlings potted in coarse or loamy sand were inoculated in the greenhouse. Inocula consisted of 9 isolates of the fungus; there were 3 control seedlings for each nine seedlings inoculated. From data on needle length and needle color, symptom condition indices were calculated for each seedling and an analysis of variance was made for the effect of inoculation. The incidence of needle blight symptoms was greater on controls. In an examination of root systems of inoculated seedlings there was no evidence that the fungus had invaded the roots. Attempts to isolate the fungus from inoculated roots were unsuccessful. In a survey of root fungi isolated from roots of 160 adjacent, diseased and healthy trees, C. galactinum was never isolated. No evidence was obtained from this study to suggest C. galactinum as a cause of white pine needle blight.

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COTTON WILT DAMAGE IN TENNESSEE

James M. Epps, B. D. Raskopf, and J. O. Andes

IMPORTANCE AND PURPOSE OF THE STUDY

For the period, 1909 to 1950, the estimated reduction in cotton yields from plant diseases in Tennessee averaged 2.2 percent or 9,500 bales annually[1]. A plant disease survey by the Experiment Station in 1919 estimated the cotton loss due to plant diseases at 33,110 bales. Much of this disease damage to the cotton crop, particularly during recent years, was due to two different kinds of wilt, Fusarium and Verticillium.

Some losses due to Fusarium wilt were reported as early as 1890 in the State, and Verticillium wilt was found in cotton fields for the first time by Sherbakoff in 1927[2]. Since that date there have been differences of opinion as to the seriousness of cotton wilt in Tennessee. The symptoms of Verticillium and Fusarium wilts are easily confused by untrained persons. Producers generally could not distinguish between wilts and some believed Fusarium-resistant vaieties were failing in performance. A very practical question also arose as to whether or not Verticillium was spreading throughout the entire cotton-growing area. This is a factor of major importance since no suitable Verticillium-resistant varieties are available.

The studies of cotton wilt were expanded in 1951 with the following objectives:

1. Determine the extent of cotton wilt damage in the principal cotton-producing area of the State over a three-year period.
2. Establish more reliable criteria of wilt loss estimates.
3. Intensify experiments directed toward control of cotton wilt.

METHOD OF PROCEDURE AND SOURCE OF DATA

The cotton wilt survey, covering three years, was begun in 1951 and included 19 counties of West Tennessee. From 10 to 20 inspections per county were made each year. Fields were inspected at random with a minimum of 5 miles between inspections. Inspections were conducted on cotton in the early fall and acres abandoned because of various causes were excluded.

Wilt damage was calculated on the basis of 100 acres of cotton inspected. For example, one inspection of 10 acres may have shown 8 acres to be wilt-clean and 2 acres showing some wilt damage. The percentage of wilt was then calculated as an average for the 2 acres. Total loss on wilt damaged cotton was estimated at 50 percent, this average being in line with controlled experiments conducted by the Experiment Station.

At each inspection where wilt was found, samples were taken and cultures made for corroborating the field observation. Specimens were cultured with minimum delay at temperatures not exceeding 20° C. Colonies were examined with a stereoscopic microscope in very early stages to prevent possible over-running of slow-growing Verticillium by a more aggressive Fusarium.

Since climatic conditions have a pronounced influence on expression of cotton wilt, the experiment was conducted for three years. The study was designed to determine the prevalence and extent of damage to cotton from both Fusarium and Verticillium wilt, by area and by season.

Limitations of the study should be recognized. It is quite possible that both types of wilt were present in all counties each year. This could be true because limitation of funds and personnel precluded the inspection of all fields in each county. Also, the field counts on percentage wilt varied considerably. For the entire area for each year the accuracy of percentage wilt estimations with 95 percent probability have an allowable error not to exceed $\pm$ 0.5 percent. On the other hand, the error between counties for each year was $\pm$ 4 percent.

Fusarium Wilt

For the 3-year period, 1951-53, Fusarium wilt was found in some fields in each of the 19 counties of West Tennessee included in the survey. The presence of Fusarium in cotton varied by area and season. Of the 19 counties, Fusarium infection was found in fields in 8 counties in 1951, 18 counties in 1952, and 13 counties in 1953 (Table 1).

On the basis of 100 acres of cotton inspected, an average of 11 to 50 acres showed the pres-

Table 1. Acreage and extent of Fusarium wilt damage to cotton, 19 counties of West Tennessee and State, 1951-53.

[1] Statistics on Cotton and Related Data, U. S. Department of Agriculture, Agricultural Marketing Service, July 1953.

[2] Tennessee Agricultural Experiment Station Reports, 1890 to 1927.

Table 1. Acreage and extent of Fusarium wilt damage to cotton, 19 counties of West Tennessee and State, 1951-53.

County	Crop year	Per 100 acres of cotton inspected: Some wilt found (acres)	Average percent wilt where found	Wilt cotton (acres)	Total loss percent (acres)	County**: Harvested acres	500 lbs. bales produced	Estimated county loss from Fusarium wilt: Acres	Bales
Decatur	1953	10	0.100	0.010	0.005	5,040	1,800	1	1
Obion	1952	20	0.100	0.020	0.010	12,200	11,700	1	1
Weakley	1952	20	0.100	0.020	0.010	12,700	9,700	1	1
	1953	20	0.100	0.020	0.010	17,000	7,000	2	1
Henderson	1952	10	0.100	0.010	0.005	25,300	16,500	1	1
	1953	10	0.100	0.010	0.005	29,165	16,000	1	1
Hardin	1952	10	3.000	0.300	0.150	12,000	6,650	18	10
Chester	1951	20	0.100	0.020	0.010	15,000	9,700	2	1
	1952	20	1.500	0.300	0.150	15,900	11,400	24	17
Hardeman	1952	30	0.400	0.120	0.060	31,800	24,300	19	15
	1953	20	0.100	0.020	0.010	35,500	25,600	4	
Haywood	1952	40	0.575	0.230	0.115	65,500	55,500	75	64
Carroll	1952	30	2.866	0.860	0.430	26,300	16,300	113	70
Crockett	1951	20	5.000	1.000	0.500	41,500	35,100	208	176
	1952	20	1.100	0.220	0.110	49,400	41,800	54	46
	1953	10	0.100	0.010	0.005	57,000	44,800	3	2
McNairy	1952	50	2.420	1.210	0.605	28,000	19,900	169	120
	1953	60	2.800	1.680	0.840	32,000	19,100	269	160
Gibson	1951	10	15.000	1.500	0.750	56,500	45,500	424	341
	1952	60	2.006	1.240	0.620	65,500	52,500	406	326
Madison	1951	20	5.000	1.000	0.500	43,500	31,800	218	159
	1952	40	7.025	2.810	1.405	50,000	33,400	703	469
	1953	50	0.100	0.050	0.025	57,000	35,600	14	9
Fayette	1952	60	16.350	9.810	4.905	64,000	46,100	3,139	2,261
	1953	20	0.100	0.020	0.010	78,500	36,100	8	4
Lauderdale	1951	10	0.100	0.010	0.005	48,500	41,100	2	2
	1952	60	5.683	3.410	1.705	54,000	47,900	921	817
	1953	20	5.050	1.010	0.505	61,600	60,400	311	305
Tipton	1951	10	12.500	1.250	0.625	57,500	50,500	359	316
	1952	40	7.000	2.800	1.400	68,500	57,000	959	798
	1953	30	2.866	0.860	0.430	84,500	62,000	363	267
Shelby	1952	100	10.520	10.520	5.260	63,500	46,000	3,340	2,420
	1953	40	1.325	0.530	0.265	63,500	49,400	168	131
Lake	1951	20	20.000	4.000	2.000	31,000	24,000	620	480
	1952	100	16.420	16.420	8.210	33,000	34,100	2,709	2,800
	1953	30	1.733	0.520	0.260	33,000	40,700	86	106
Dyer	1951	60	27.500	16.500	8.250	48,000	33,300	3,960	2,747
	1952	60	5.050	3.030	1.515	46,000	42,300	697	641
	1953	40	7.550	3.020	1.510	77,100	46,200	1,164	698
5 Delta Counties*	1951	18	22.189	3.994	1.997	247,500	188,100	4,941	3,545
	1952	69	9.435	6.510	3.255	265,000	227,300	8,626	7,476
	1953	32	3.644	1.166	0.583	319,700	258,700	2,092	1,507
19 Counties	1951	11	15.791	1.737	0.869	666,750	483,880	5,793	4,222
	1952	50	7.324	3.662	1.831	729,100	575,710	13,349	10,877
	1953	21	2.619	0.550	0.275	866,727	614,000	2,395	1,688
State	1951	11	14.582	1.604	0.802	765,000	534,000	6,135	4,281
	1952	50	6.964	3.482	1.741	835,000	638,000	14,537	11,110
	1953	21	2.476	0.520	0.260	945,000	690,000	2,461	1,726

* The five Delta counties include: Lauderdale, Tipton, Shelby, Lake, Dyer.

** Data on harvested acres and production were secured from the State Agricultural Statistician and County Agents. Production for 1953 is based on bales ginned as of January 16, 1954 and preliminary estimates of harvested acres.

Table 2. Acreage and extent of Verticillium wilt damage to cotton, 19 counties of West Tennessee, and State, 1951-53.

County***	Per 100 acres of cotton inspected					County***		Estimated county loss from Verticillium wilt	
	Crop year	Some wilt found (acres)	Average percent wilt where found	Wilt cotton (acres)	Total loss percent (acres)	Harvested acres	500 lbs. bales produced	Acres	Bales
Chester	1951	10	0.100	0.010	0.005	15,000	9,700	1	1
Hardeman	1953	10	0.100	0.010	0.005	35,500	25,600	2	1
Madison	1953	10	0.100	0.010	0.005	57,000	35,600	3	2
Gibson	1952	10	0.100	0.010	0.005	65,500	52,500	3	3
	1953	10	0.100	0.010	0.005	79,000	58,600	4	3
Crockett	1951	10	5.000	0.500	0.250	41,500	35,100	104	88
Lauderdale	1951	10	0.100	0.010	0.005	48,500	41,100	2	2
Tipton	1952	20	7.500	1.500	0.750	68,500	57,000	514	428
	1953	10	3.500	0.350	0.175	84,500	62,000	148	109
Dyer	1951	30	16.666	4.500	2.250	48,000	33,300	1,080	749
	1953	40	23.750	9.500	4.750	77,100	46,200	3,662	2,195
Lake	1951	60	34.166	20.499	10.250	31,000	24,000	3,178	2,460
	1952	40	28.775	11.510	5.755	33,000	34,100	1,899	1,962
	1953	70	17.171	12.020	6.010	33,000	40,700	1,983	2,446
5 Delta Counties*	1951	15	22.947	3.442	1.721	247,500	188,100	4,260	3,211
	1952	10	18.220	1.822	0.911	265,000	227,300	2,413	2,390
	1953	21	17.157	3.624	1.812	319,700	258,700	5,793	4,750
19 Counties**	1951	7	18.714	1.310	0.655	666,750	483,880	4,365	3,300
	1952	5	13.280	0.664	0.332	729,100	575,710	2,416	2,393
	1953	11	12.164	1.338	0.669	866,727	614,000	5,802	4,756
State	1951	7	16.714	1.170	0.585	765,000	534,000	4,477	3,357
	1952	5	11.600	0.580	0.290	835,000	638,000	2,422	2,396
	1953	11	11.164	1.228	0.614	945,000	690,000	5,804	4,758

* Includes counties of Lauderdale, Tipton, Dyer, Lake and Shelby.

** Includes counties listed in above table plus Decatur, Obion, Weakley, Henderson, Hardin, Haywood, Carroll, McNairy, Fayette, and Shelby.

***Data on harvested acres and production were secured from the State Agricultural Statistician and County Agents. Production for 1953 is based on bales ginned as of January 16, 1954 and preliminary estimates of harvested areas.

Table 3. Economic significance of Fusarium and Verticillium damage to cotton in 19 counties of West Tennessee, and

Table 3. Economic significance of Fusarium and Verticillium damage to cotton in 19 counties of West Tennessee, and State, 1951-53.

County	Fusarium wilt			Verticillium wilt			Total		
	Loss 1951-53 (Bales)	Average annual loss (Bales)	Average annual value (dollars)*	Loss 1951-53 (Bales)	Average annual loss (Bales)	Average annual value (dollars)*	Loss 1951-53 (Bales)	Average annual loss (Bales)	Average annual value (dollars)*
Decatur	1	0.3	39				1	0.3	39
Obion	1	0.3	39				1	0.3	39
Weakley	2	0.7	91				2	0.7	91
Henderson	2	0.7	91				2	0.7	91
Hardin	10	3.3	429				10	3.3	429
Chester	18	6.0	780	1	0.3	39	19	6.3	819
Hardeman	18	6.0	780	1	0.3	39	19	6.3	819
Haywood	64	21.3	2,769				64	21.3	2,769
Carroll	70	23.3	3,029				70	23.3	3,029
Crockett	224	74.7	9,711	88	29.3	3,809	312	104.0	13,520
McNairy	280	93.3	12,129				280	93.3	12,129
Gibson	667	222.3	28,899	6	2.0	260	673	224.3	29,159
Madison	637	212.3	27,599	2	0.7	91	639	213.0	27,690
Fayette	2,265	755.0	98,150				2,265	755.0	98,150
Lauderdale	1,124	374.7	48,711	2	0.7	91	1,126	375.3	48,789
Tipton	1,381	460.3	59,839	537	179.0	23,270	1,918	639.3	83,109
Shelby	2,551	850.3	110,539				2,551	850.3	110,539
Lake	3,386	1,128.7	146,731	6,868	2,289.3	297,609	10,254	3,418.0	444,340
Dyer	4,086	1,362.0	177,060	2,944	981.3	127,569	7,030	2,343.3	304,629
19 Counties	16,787	5,596.3	727,519	10,449	3,483.0	452,790	27,236	9,078.7	1,180,231
State**	17,117	5,705.7	741,741	10,511	3,503.7	455,481	27,628	9,209.3	1,197,209

* Value of cotton during the 3-year period averaged $130 per bale.

** In estimating state losses the incidence of wilt in cotton-producing counties not included in the survey was assumed to be the same as that found for upland cotton in 14 counties surveyed.

ence of Fusarium wilt during the three-year period. In fields where Fusarium was found the percentage of wilt, by counties, ranged from an average of 0.1 in the Counties of Decatur, Obion, Weakley, and Henderson, to over 20 in Lake and Dyer Counties. In a few infested fields within the Delta counties it exceeded 50 percent. The percentage of wilt in all infested fields of the 19 counties averaged 15.8 in 1951, 7.3 in 1952, and 2.6 in 1953.

The percentage total loss of cotton due to Fusarium varied widely by counties and by years. In 1951 the losses ranged from none in 11 counties, to 8.2 percent in Dyer County. In 1952, losses ranged from none in Decatur County, to 8.2 percent in Lake County. Losses were lower in 1953, six counties having none, and the highest found being 1.5 percent in Dyer County.

Based upon the wilt survey for the three years, the cotton losses due to Fusarium wilt were estimated for the 19 counties. These losses were 4,222 bales in 1951, 10,877 bales in 1952, and 1,688 bales in 1953. During the three-year period the losses in the five Delta counties accounted for 75 percent of the total losses estimated for the 19 counties.

Serious losses from Fusarium wilt in cotton were not limited to the Delta counties of Lake, Dyer, Lauderdale, Tipton, and Shelby. As shown in Table 1 heavy losses also occurred in one or more years in the upland counties of Gibson, Crockett, McNairy, Madison, and Fayette.

The survey indicates that the incidence of Fusarium wilt varies extremely by years. For example, Fayette County showed no losses in 1951, 2,261 bales in 1952, and 4 bales in 1953. Gibson County showed losses of over 300 bales in 1951 and 1952 but no damage in 1953.

Verticillium Wilt

During the period of this study, 1951-53, Verticillium cotton wilt was found in 9 of 19 counties in West Tennessee. In 1951, some Verticillium was found in the counties of Chester, Crockett, Lauderdale, Dyer, and Lake. The following year the presence of this wilt was noted in Gibson, Tipton, and Lake Counties. In the 1953 survey some Verticillium was found in Hardeman, Madison, Gibson, Tipton, Dyer, and Lake Counties. On the basis of 100 acres of cotton inspected, an average of from 5 to 11 acres showed the presence of some Verticillium wilt during the three-year period. In fields where Verticillium was found the percentage wilt, by counties, ranged from an average of 0.1 in Chester, Hardeman, Madison, Gibson, and Lauderdale Counties, to 34 in Lake County. In a few infested fields in Lake and Dyer Counties there was more than 50 percent wilt. For the 19 counties the proportion of Verticillium in infested fields averaged 19 percent in 1951, 13 percent in 1952, and 12 percent in 1953 (Table 2).

The percentage total loss, per 100 acres, varied widely by counties and by years. During the three-year period no losses were reported from Verticillium in Decatur, Obion, Weakley, Henderson, Hardin, Haywood, Carroll, McNairy, Fayette, or Shelby Counties. On the other hand, it was estimated that from 6 to 10 percent of the total cotton crop in Lake County was lost because of wilt damage during the three years.

When total losses are translated into bales of cotton they become quite significant for some counties. The total cotton loss from Verticillium in 19 counties of West Tennessee was estimated at 3,300 bales in 1951, 2,393 bales in 1952, and 4,756 bales in 1953. During the three-year period the loss in Lake County accounted for 66 percent of all losses. As shown in Table 2, the counties of Dyer and Tipton also sustained important losses from Verticillium in one or more years.

Serious losses from Verticillium appear to be limited to the Delta counties. Nevertheless, infection by Verticillium may become serious in the upland areas, as shown by the fact that loss in Crockett County was estimated at 88 bales in 1951, although no Verticillium could be verified in this county in the other two years.

ECONOMIC SIGNIFICANCE OF COTTON WILT DAMAGE

During the period 1951-53 the average annual loss in Tennessee from cotton wilt damage was estimated at 9,209 bales valued at $1,197,000 (Table 3). Of this loss 62 percent was due to Fusarium and the balance to Verticillium wilt. This loss does not include acreage abandoned because of disease and the effects of wilted cotton on the grade of all cotton marketed.

Significant average annual losses occurred in the five Delta counties of Lauderdale, Tipton, Shelby, Lake, and Dyer, and in the upland cotton-producing counties of Crockett, McNairy, Gibson, Madison, and Fayette. Losses in nine other counties of West Tennessee are not significant for the county as a whole but may be of importance on individual farms heavily infected with wilt.

UNIVERSITY OF TENNESSEE, KNOXVILLE

THE OCCURRENCE OF VERTICILLIUM WILT IN COTTON AS INFLUENCED BY THE LEVEL OF SALT IN THE SOIL

P. D. Christensen, L. S. Stith, and P. J. Lyerly[1]

Verticillium wilt (V. albo-atrum) in short staple cotton (Gossypium hirsutum) is a major problem in the El Paso Valley in Texas and in other areas in the Southwest. Yield reductions resulting from infection range from less than 5 to more than 50 percent. Severity of wilt varies from season to season and from soil to soil. An area of severe wilt in a field may be adjacent to areas relatively free of wilt.

In 1950, a study was initiated at the Ysleta station to determine whether certain properties of the soil could be correlated with the occurrence of the wilt. This paper reports preliminary findings in a study aimed at determining the severity of wilt as influenced by the salt status of the soil.

Table 1. Severity of Verticillium wilt of cotton in the El Paso Valley as related to the electrical conductance of saturated extracts of the soil.

None to Slight Wilt		Slight to Moderate Wilt		Moderate to Severe Wilt	
0-6"	6-12"	0-6"	6-12"	0-6"	6-12"
		EC x 10^3			
		1950			
9.5	8.3			3.0	3.8
				3.3	
6.2	8.5			1.5	1.6
6.5	7.6			2.4	5.0
		1952			
1.1	5.0	15 *	2.2	1.0	1.7
15 *	15.0	7.5	7.5	4.0	3.7
15 *	15 *	5.5	8.2	10.5	2.4
15 *	9.5	1.2	0.4	6.5	5.5
15 *	15 *	7.0	- -	1.9	1.8
11.5	9.0	3.8	4.0	2.0	13.0
14.0	7.0	4.2	2.7	1.3	1.8
15 *	15 *	0.6	0.7	0.7	0.6
10.0	6.0	6.3	2.0	2.1	2.0
6.5	2.6	0.9	1.1		
4.5	15 *	1.3	1.3		
11.0	9.5	0.5	1.1		
3.4	7.9	0.7	0.7		
1.4	1.2	6.0	6.0		
9.0	9.2	12.0	3.6		
0.6	1.3	7.5	8.2		
0.6	1.0				

* Greater than 15.0

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Cotton leaves and samples of soil were collected in 1950 in cotton strain plots in a field where Verticillium infection varied widely. The samples were collected in severely infected areas and in adjacent areas of slight infection. In a similar manner, soil samples were collected in fields of commercial cotton. The same procedure was followed in 1952, but was expanded over the entire Valley. Observational and laboratory results of these studies are summarized in Table 1. The problem was further investigated by means of a pot test in the greenhouse in which the soil was artificially salinized to four levels with seven different salt mixtures.

The data show a negative correlation between the severity of wilt in cotton and the electrical conductance of the soil saturation extracts. In the field studies, the incidence of wilt was markedly less where the conductance of the saturation extract exceeded 5 millimhos per cm. Above 10 millimhos per cm, little wilt in cotton was observed. Results of the pot test were very similar. Several obvious exceptions to the trend were found. The overall picture, however, strongly indicates that as the salt concentration in the soil increases, severity of wilt in cotton decreases. Of interest is the fact that in the 1950 cotton leaf samples, the concentration of sodium was approximately four times greater in the non-wilt plants than in those severely affected with the disease.

To the authors' knowledge, the salt factor in the Verticillium wilt problem has been largely overlooked. The results of these preliminary studies indicate that the salt relations in the soil may help to explain results of other experiments. High double beds and fallowing, which have been found to reduce amount of wilt, could have the effect of increasing the salt level in the root zone of the plant. The severity of wilt generally increases with increase in soil moisture, which also tends to lower the concentration of salt in the soil solution.

Other factors are involved in the wilt problem, and they should not be minimized; however, the salt factor should be given due consideration.

EL PASO VALLEY EXPERIMENT STATION, YSLETA, TEXAS

THE RESISTANCE OF KENAF VARIETIES, HYBRIDS, AND RELATIVES TO ANTHRACNOSE[1]

Bowen S. Crandall and Harold D. Lynn[2]

In the course of the 1952 and 1953 kenaf (Hibiscus cannabinus) breeding and selection programs, more than 60,000 individual kenaf plants and near relatives were needle-inoculated to determine resistance or susceptibility to anthracnose (Colletotrichum hibisci Poll.). These populations had been intensively selected during the natural epiphytotic of 1951 and in addition were survivors of the original attack, which occurred in 1950.

Current investigations on the mechanics of resistance indicate that susceptibility of all but the most resistant selections increases at flowering time and during the cooler winter weather. The results here reported are of that period and therefore represent reactions under conditions most favorable for the disease.

Judging only by appearance of the anthracnose fungus in culture, there is a distinct possibility of the existence of various strains in Cuba. Pending the outcome of investigations on the virulence of individual lines, inoculum is being made from water suspensions of spores washed from cultures on sterilized kenaf seed. Some 45 different isolates are mixed to prepare the inoculum. These isolates vary greatly in appearance and have been taken under different climatic conditions, from seed stored at different temperatures, from different symptomatic manifestations of the disease such as leaf spots, stem cankers, and tip blight, and finally from the different kenaf types and from H. sabdariffa.

Table 1 gives the percentage of susceptibility shown by different kenaf varieties following inoculation in 1952. The Tingo Maria selection apparently often carries additional resistance to the disease before flowering time and during long days, since field infections often fall well below the 95 percent susceptibility determined by inoculation. This same type of resistance has appeared in some of the progeny of the (TM x S) crosses shown in Tables 2 and 3.

Table 1. Susceptibility to anthracnose of kenaf varieties.

Introduction number	Common name	Susceptibility (percent)	Stem and leaf characteristics[a]	Varietal classification
PI-190126	Tingo Maria	95	P-E	simplex
PI-189127	El Salvador	44	G-D/E	vulgaris x viridis
PI-173211	Formosan	100	P-D	purpureus
PI-173215	Chinese	100	G-D	vulgaris
PI-173227	Chinese	100	G-D	vulgaris
Stbno-14	Javanese	100	P-D	purpureus
Stbno-90	Javanese	100	P-D	purpureus
PI-173214	Korean	100	G-D	vulgaris
PI-173222	Manchurian	100	G-D	vulgaris
PI-173223	Manchurian	100	G-D	vulgaris
PI-173225	Manchurian	100	G-D	vulgaris

[a] Stem color -- G = green, P = purple. Leaf -- E = entire, D = divided.

[1] A contribution of the Cooperative Fiber Commission, a technical service organization of the Cuban Ministry of Agriculture, operated in collaboration with the Foreign Agricultural Service of the United States Department of Agriculture. The work here reported was supported by funds of the Cuban government and of the United States under the Point IV (now United States Operations Mission to Cuba) program administered by the Institute of Inter American Affairs under the Foreign Operations Administration.

[2] Research Adviser, Plant Pathology and Research Specalist, Plant Breeding, Foreign Agricultural Service, United States Department of Agriculture.

Table 2. Resistance in kenaf varieties and hybrids.

Selection or cross	Number of families in X generation, 1950	Number of families of descendants in XIV generation, 1952, resistant is indicated		
		Highly	Some	None
El Salvador (S)	48	25	226	72
Java	5	0	3	9
China	2	0	1	1
Korea	1	0	0	1
Manchuria	3	0	1	2
Tingo Maria (TM)	4	3	5	4
Brazil (B)	3	0	1	4
Formosa	1	0	0	2
H. diversifolius (D)	-	Immune		
S x TM	9	5	32	11
S x D	1	0	2	1
S x B	2	3	7	2
TM x D	1	0	1	0
(S x TM) x D	2	0	7	2
(S x TM) x S	17	60	230	81
(S x S) x (TM x S)	2	2	14	2

Table 3. Resistance in XV generation kenaf selections and crosses.

Selection or cross	Number of families in X generation which survived into XV by having some resistance	XIV generation selections for resistance which survived[a] or were eliminated in XV generation		Number of selections of individual plants to become rows in XVI generation
		Eliminated	Survived	
El Salvador (S)	42 of 48	290	122	251
Tingo Maria (TM)	1 of 4	7	1	1
S x TM	3 of 9	43	7	37
(S x TM) x S	18 of 19	365	33	306
S x D	1 of 1	0	3	2
TM x D	1 of 1	0	2	1
(S x TM) x D	2 of 2	10	3	7
S x B	2 of 2	20	2	10
Java (J)	0	-	-	-
[(S x TM) x S] J	-	0	1	66
S x J	-	0	1	9

[a] Survived as one or more plants with the minimum acceptable symptoms of a few leaf spots or an occasional stem spot at maturity.

Fiber roselle, Hibiscus sabdariffa var. altissima, is the favored fiber producer in the East Indies. Under Cuban conditions, four selections being tested (PI-159886, and 182835, STBNO-12 and 44) have been free from natural attack, although when needle-inoculated they were found to be 100 percent susceptible. The disease, however, is not severe as in kenaf. No dieback is present, and although sporulating cankers on the stem are common, the plant continues growth and does not seem adversely affected as a fiber producer. Edible roselle, H. sabdariffa, is highly resistant but not immune and also shows considerable resistance to natural infection.

In addition to Hibiscus diversifolius, H. abelmoschus, H. costatus, H. esculentus, H. rosa-sinensis, Gossypium hirsutum (Pima cotton), G. barbadense (Upland cotton), Urena lobata, Sida rhombifolia, S. cordifolia, and Abutilon angulatum are apparently immune. All local Malva spp. tested have been immune but a kenaf-like Malva from Guatemala is somewhat susceptible.

Table 3 summarizes the status of resistance at the end of 1953. Inheritance of resistance is apparently controlled by more than one pair of recessive genes. Although the mechanics of resistance are still under investigation the knowledge of its multiple nature allowed a much more critical selection to be made.

The varieties Java, Chinese, Manchurian, Korean, Brazil, and Formosa were eliminated because of susceptibility.

COOPERATIVE FIBER COMMISSION, HABANA, CUBA

PLANT DISEASE OBSERVATIONS IN THE IRRIGATED AREAS OF CENTRAL WASHINGTON DURING 1953

J. D. Menzies[1]

New areas are coming under irrigation each year in central Washington as a result of the progressive development of the Columbia Basin and other smaller irrigation projects. New crops are also becoming important in the area. These factors lead to a rapidly changing plant disease situation which is sometimes difficult to evaluate. New disease records for the area may represent the initial stages of disease problems that will become important or may only be chance introductions that will seldom recur. It is therefore important to record these occurrences and the circumstances under which they appeared. Following are the more noteworthy new records or unusual developments of plant diseases in irrigated central Washington during 1953.

MINT (Mentha spp.) -- Rust (Puccinia menthae) was observed for the first time in eastern Washington in July 1953. The disease was found only in one field, a planting of spearmint (Mentha spicata) near Sunnyside. This field was irrigated by the furrow method except for a small portion which, because of topography, had to be irrigated by an overhead sprinkler. Rust was severe within the area covered by the sprinkler but was not found in the rest of the field until October, by which time slight spread of rust to the lower leaves over most of the 40-acre field had occurred.

This observation is significant because a recent rapid increase in acreage of spearmint and peppermint (M. piperita) has occurred in the irrigated areas following damaging outbreaks of mint rust in the important mint growing sections on the Pacific Coast. According to the grower the field referred to above was planted with roots obtained from stock that had been increased in the Yakima valley for several years. Consequently the rust infection cannot be attributed directly to introduction of infected planting stock. The fact that damage was restricted to the part of the field that was sprinkled indicated that rust may not become an important disease in row-irrigated plantings, but does forecast a problem for growers using overhead irrigation.

Powdery mildew (Erysiphe cichoracearum) occurred generally on both peppermint and spearmint throughout the Yakima Valley during 1953. Some early defoliation resulted but hot weather during the middle of July apparently arrested the disease. The final effects on yield were probably minor. Since this mildew was so prevalent during the past season it has doubtless been present on mint for some years but has escaped attention. There is no record of this mildew on cultivated mint in Weiss and O'Brien's "Index of Plant Diseases in the United States", but Horner (1) described the conidial stage of a mildew on mint in Oregon in 1952. He did not observe perithecia. In contrast there was abundant production of perithecia on the mildew observed in the Yakima Valley, both on peppermint and spearmint. The characteristics of this stage are typical of E. cichoracearum.

The mint mildew threatened to cause serious defoliation early in the season. In our experience powdery mildews may often continue to spread during hot weather so it is too early to conclude that this disease will be unimportant. It has potentialities for becoming more of a problem than rust for the irrigated areas. As in the case of rust, control measures will be complicated by the danger of contamination of the mint oil by fungicides.

DRY BEANS -- Rust (Uromyces phaseoli) was previously reported on sprinkler-irrigated beans grown on the Pasco project (3). This year it was more general in the Pasco area and was also noted in the vicinity of Moses Lake. In only one case was rust found in beans irrigated by rills. This was a late-maturing field of the Red Mexican variety grown near Moses Lake. The rust was not early enough nor severe enough in this case to cause any yield loss.

Pod rot (Botrytis sp.) can usually be found to some extent in most bean fields, particularly on pods that touch the ground. An exceptionally damaging amount of pod infection was noted in a field of the Small Flat White variety grown under sprinklers in the Moses Lake area. Counts of 100 plants in eight locations in this 60-acre field showed an average of 18 percent of the pods infected. Most of these were shrivelled and dry and covered with a mass of sporulating mycelium. Soil contact was an important contributing feature but in many cases very young pods were destroyed near the top of the plants. The soil of this field was very sandy and probably

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required frequent irrigation. Also the plants were not hilled, a practice which would have kept more of the pods from soil contact.

Root rot (Fusarium solani f. phaseoli) has rapidly assumed a position of first importance as a disease of dry beans in newly irrigated land. A survey of 30 bean fields revealed the importance of lack of rotation in the buildup of this disease. From only a trace the first year the percentage of infected plants increased to 37 the second year, 70 the third, 90 the fourth, and 100 in the fifth. In spite of this situation growers have neglected rotations in favor of repeating beans as a cash crop for economic reasons. Yield losses are considerable but are not in proportion to the percentage infection because the bean plant can produce new roots even though the tap root system is progressively destroyed by root rot. High hilling and heavy irrigation must be practiced to establish these new roots.

ASPARAGUS -- Rust (Puccinia asparagi) again appeared in the Yakima Valley after an absence of several years. In 1940-42 this rust increased to a point where it was important, particularly on new plantings and seedling beds (2), but since then it has been rare or absent. Its reappearance this year may be related to recent mild winters and a relatively cool moist early summer. The disease, which occurred on the Mary Washington variety and the California selection #600, was found only in the Granger area.

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3. _____. 1952. Observations on the introduction and spread of bean diseases into newly irrigated areas of the Columbia Basin. Plant Dis. Reptr. 36: 44-47.

SOIL AND WATER CONSERVATION RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, IRRIGATION EXPERIMENT STATION, PROSSER, WASHINGTON

BRIEF NOTES

TEACHING OF PLANT PATHOLOGY AT WEST VIRGINIA UNIVERSITY

By C. R. Orton

In the Plant Disease Reporter of February 15, 1954, I find an interesting statement by Roy Bardin relative to Ralph Smith establishing the first course in plant pathology and the first department of plant pathology in a United States university.

In the Plant Disease Reporter, Supplement 191: 112-118, 1950, in the article on "Plant Pathology at West Virginia University" I pointed out that Dr. J. L. Sheldon was appointed Plant Pathologist in the Experiment Station in 1903 -- certainly one of the earliest appointments under this title in the United States.

Apparently Whetzel was unaware of both the California and West Virginia appointments when he wrote his "History of Plant Pathology." There may be some question whether these two early appointments can claim to be of departmental status.

WEST VIRGINIA UNIVERSITY, MORGANTOWN

ANNOUNCEMENT

COINED NAMES FOR FUNGICIDAL CHEMICALS: The American Phytopathological Society's Special Committee on Fungicide Nomenclature announces approval of two more common names. They are:

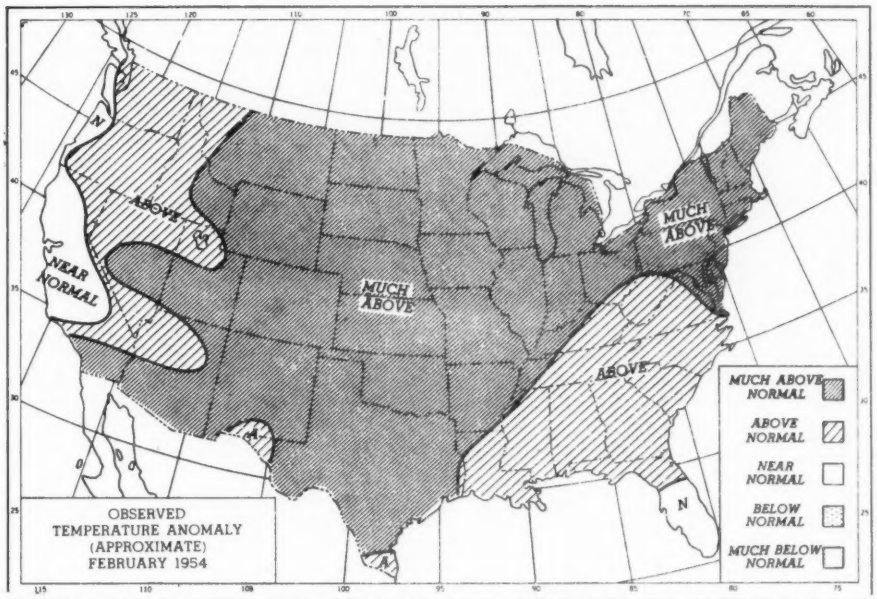
Dichlone -- for the fungicidal chemical 2, 3-dichloro-1, 4-naphthoquinone.

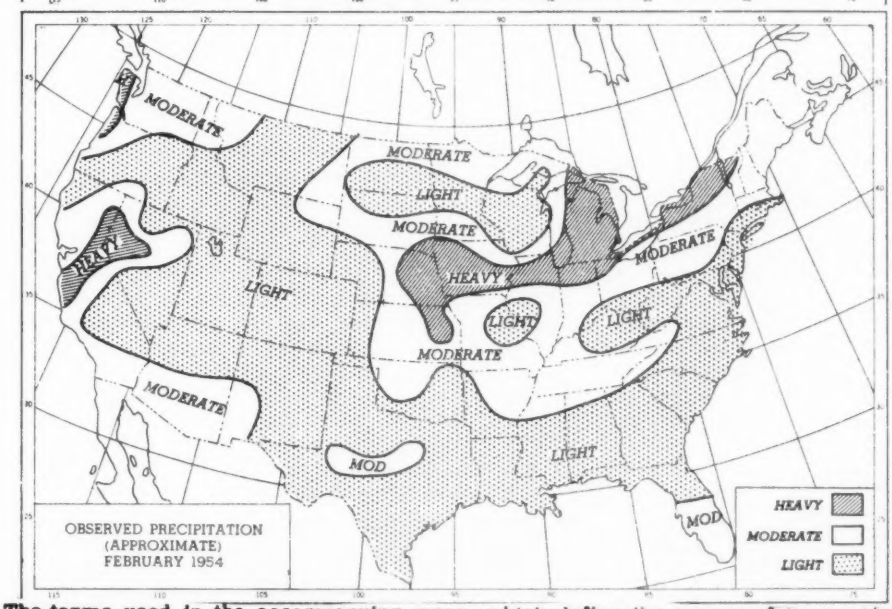
Glyodin -- for the fungicidal chemical 2-heptadecyl glyoxalidine acetate.

ATTENTION PLEASE!

It has been suggested that the Reporter follow the practice recommended by A. I. B. S., and adopted by Phytopathology and other journals, of requesting brief abstracts for the beginning of articles. The abstracts serve many purposes, not the least of which is the help they give the abstracting journals. Please note -- send abstracts.

Therefore, we ask contributors to include abstracts whenever the length or content of articles makes the brief statement desirable.





The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.